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THE FIRST ALL INDIA SCIENCE CONFERENCE
Organized by
BREAKTHROUGH SCIENCE SOCIETY

THE Breakthrough Science Society (BSS) organised its first All India Science at the KEB Engineers Association Hall, Bangalore from Oct 17 to 19, 2014. Around 500 delegates comprising of professors, research scholars, lecturers, postgraduate students, graduate students from 16 states of the country actively participated in the deliberations on all the three days. In the preparatory phase of the conference there was tremendous response from the science professionals, teachers, students and general public. Breakthrough Science Society received phone calls from interested people across the country to know the details of the programme. Hundreds of organisers tirelessly worked towards the success of the event. More than 50 leading scientists in the country sent congratulatory messages, joining the scientific community in wishing the programme all success.

The Conference kick-started with a unique event that BSS called "March for Science". The march was flagged off by Smt Indumathi Rao (Honorary Coordinator of the multimedia group at Jawaharlal Nehru Centre for Advanced Scientific Research) at 11.30 am from the Freedom Park. In her brief address, she congratulated BSS for its efforts in taking science to the common man and was highly appreciative of the commitment of its volunteers. She wished the event great success and called upon the students especially school children to pursue science as a passion.

The March was visualised by the organisers to uphold the ethos and aspirations of the entire scientific community and to draw the attention of the country towards making science a way of thinking and living. There were school children from across Karnataka who dressed up like famous scientists, followed by hundreds of children from various schools in Bangalore who held the portraits of scientists, and placards with famous quotes from great men of science: Try not to become a man of success, rather become a man of values – Albert Einstein; Nothing in life is to be feared, it is only to be understood – Madame Curie; Science knows no country, because knowledge belongs to humanity – Louis Pasteur; and slogans like – 'Science for the common man', 'We are for safe energy', 'Ethics and science need to shake hands', etc.

Delegates from various states marched behind their respective state banners and over a thousand people including research scholars, post-graduate students, graduate students, engineering graduates, lecturers, teachers and general public participated in the march.

The March proceeded to the venue of the Conference — KEB Engineers Association Auditorium, Bangalore. Following the March, the Chart and Quotation exhibition

Participants of the march assembling at Freedom Park, Bangalore.

was inaugurated by Dr. R. Manivannan (Head, Dept of Political Science and Public Administration, University of Madras) at the venue of the Conference. The science loving people gathering at the venue went through the exhibition. Many of them expressed desire to become members of the science organisation and to shoulder responsibilities in taking forward the science movement.

The Open Session

Prof Roddam Narasimha (Eminent Aerospace Scientist, Former Director NAL and NIAS) inaugurated the Conference at 2.30 PM at the KEB Engineers Association Auditorium. In his inaugural address, he spoke about the achievements of Indian Science in the past. He pointed out that "It is not fair to claim that everything the world knows today was already known by the ancient Indians, neither is it fair to say that nothing was known to the ancient Indian civilisation." He demanded a scientific study on the history of Indian Science and opined that we should only lay claim based on such a scientific study and on on the basis of beliefs. He dealt in detail with the contributions of Charaka, Sushrutha, Aryabhata, Bhaskara, Neelakantha and spoke about the Lokayatas and the Charvakas in his detailed presentation on the history of Indian Science. He also spoke on the technological advancements such the rocket technology developed during the rule of Tipu Sultan.

Messages from the eminent scientists of the country were read out to the audience. Dr. R Manivannan spoke on the contributions of heroes of science in propagating the scientific spirit and scientific temperament. He then placed a wreath on the column erected in memory of heroes of science.

After the Open Session, the first delegate session was dedicated to the topic "Why the present scientific education is not developing a scientific bent of mind?." The speakers of the panel discussion were introduced by Mr. G. Satish Kumar, and Prof. P. N. Thankachan moderated the panel discussion. The panelists were Dr. B. S. Shylaja (Director, JN Planetarium and a popular science writer), Prof. S. Mahadevan (MRDG Lab, IISc, Editor of *Resonance*), Dr. Ganesh Bhatta (Principal, MES Teachers College,

Smt. Indumathi Rao flagging off the March. Also seen in the picture are school-children dressed as famous scientists.

Bangalore and a well-known science populariser) and Prof. Dhrubajyoti Mukherjee (Honorary INSA Scientist, Retd Prof of Geology, Calcutta University).

Dr. B. S. Shylaja presented the prevailing superstitions about the solar system and celestial objects. Prof. S. Mahadevan spoke on the ways of developing a scientific temperament through science journals and media and ways of making science a way of life. Dr. Ganesh Bhatta spoke on the effective ways of developing a scientific temperament in the teaching curriculum and in personal life. Prof. Dhrubajyoti Mukherjee spoke on the lack of will on the part of the authorities in imparting scientific temperament and scientific bent of mind to the people. The first day concluded with a question answer session on the panel discussion, in which the delegates actively participated.

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The second day began with Padma Bhushan Prof. U. R .Rao (Internationally renowned Space Scientist, Former Chairman ISRO) delivering the inaugural address to the delegates about the plight of science in India. He spoke of his experiences with the scientists of the yore like Dr. Homi Bhabha, Dr. Vikram Sarabhai, Prof. Meghanad Saha, Prof. S. N. Bose, and Dr. Abdus Salam. He bemoaned the fact that our country is lagging behind in the application of Science and Technology. Despite having enough resources, we remain in the forefront of poverty, as very little importance is given to science. He also emphasized that without progress of Science and Technology, there will be no progress of the country. "Take up science as a passion and not for the sake of career," urged Prof. U. R. Rao.

Sri Nagesh Hegde (Popular Science Writer) addressed the delegates on "Role of science in the social good". He clearly distinguished the difference between dazzling science and stark reality by illustrating the irony of the fact that we have instruments to detect methane in Mars but none for detection of toxic gases in manholes due to which workers die while cleaning manholes. He highlighted the different aspects of depletion of natural resources, bio-diversity, fossil fuels, food production, and insisted

Dr. R. Manivannan inaugurating the Chart and Quotation exhibition.

on making viable use of alternative sources of energy and green technology.

In the next session a Presidium was proposed to conduct the business of the delegate session. Under the conduction of the Presidium, first a condolence resolution was passed. The delegates observed a minute's silence in memory of the lives dedicated in service of science. Then the Manifesto for a Science Movement was tabled and the delegates deliberated on it. After that, three resolutions were proposed (given later in this report), and there was further deliberation on these.

A Panel Discussion on "Cultivation and spread of a scientific culture — Challenges and the way forward" was held in the afternoon. The panelists were Prof. Bala Iyer (Theoretical Physics Group, Raman Research Institute, Chairperson of the IndIGO Consortium), Prof. Satyajit Mayor (Director, National Centre for Biological Sciences, Bangalore), Dr. Moncy V. John (Retd. Professor, St. Thomas College, Kozhencherry, Kerala), Prof. Soumitro Banerjee (Professor and Dean of Students, IISER Kolkata). The session was moderated by Mr. K. G. Satish (Principal Software Architect in a leading software firm, and Karnataka State Convener, BSS).

Prof. Mayor illustrated the bright future of research in biology, and the career prospects in that area. He also dealt in detail about the need to spread scientific culture in research centres as well. Prof. Bala Iyer extensively quoted from various science popularisers including Feynman, Asimov and argued his case in favour of the necessity of spreading scientific culture and the ways of spreading it. Dr. Moncy John spoke on the divisive tendencies thriving in the scientific community and called upon the delegates to be watchful about the same. Prof. Banerjee spoke on the stark dichotomy between technological advancements and the lack of basic civic facilities to the common man. He criticized the fact that the school curriculum is heavy with information and high-sounding words which the students cannot grasp at that age. He felt that unless the concepts of science are taught like a well-knit story with illustration from day-to-day life, science will remain just a "subject" that has to be learnt for the sake of building a career.

In the evening session, Prof Uday Maitra, (Professor, Dept of Organic Chemistry, Indian Institute of Science, Bangalore) demonstrated a few eye-catching chemistry experiments which demonstrated how exciting chemistry can be.

The day concluded with cultural programs by the delegates and for the delegates. Dr. Manabendra Nath Bera, (Research scholar, Harishchandra research Institute), Dr. M. R. Sridharan (Scientist, CLRI and Convener, Science Club, Chennai), Smt. Neeraja (Hindi officer, CLRI, Chennai) rendered melodious songs, and Prof. Soumitro Banerjee played the violin.

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The final day began with the presentation of an organisational report of the BSS activities across the country. The draft Constitution of the BSS was tabled next. The dele-

Mr. G. Satish Kumar briefing the dignitaries about the charts.

gates actively participated in offering suggestions, corrections and amendments to both the documents. The presidium meticulously took note of all the deliberations and both the resolutions were passed with a commitment to incorporate the necessary changes in the documents.

Finally the first National Executive Committee of the Breakthrough Science Society was proposed, with Prof. Dhrubajyoti Mukherjee as the President and Prof. Soumitro Banerjee as the General Secretary. The proposed committee was unaniously elected by the house. The General Council of the BSS was also proposed and was elected. The Conference concluded with a resolve to launch a new science movement, guided by the resolutions passed. At the first stage of this movement, it was decided to take up the demand to all state governments to adopt an anti-superstition, anti-black magic bill.

Messages from eminent people

Message from Bharata Ratna Prof. C. N. R. Rao

Science is a part of the lives of all citizens. In particular, scientific attitude is essential for dealing with problems in life as well as of society. In particular, school science education is of crucial importance since our future depends on the young people of today. We should improve the quality of school education and give teachers greater importance in our value system. We should spend at least 6% of the GDP on education, instead of 2% as at present. Finally, real improvement in education will occur only when society as a whole participates in social movement. It is only then that scientific temper can be expected to play a role in our lives.

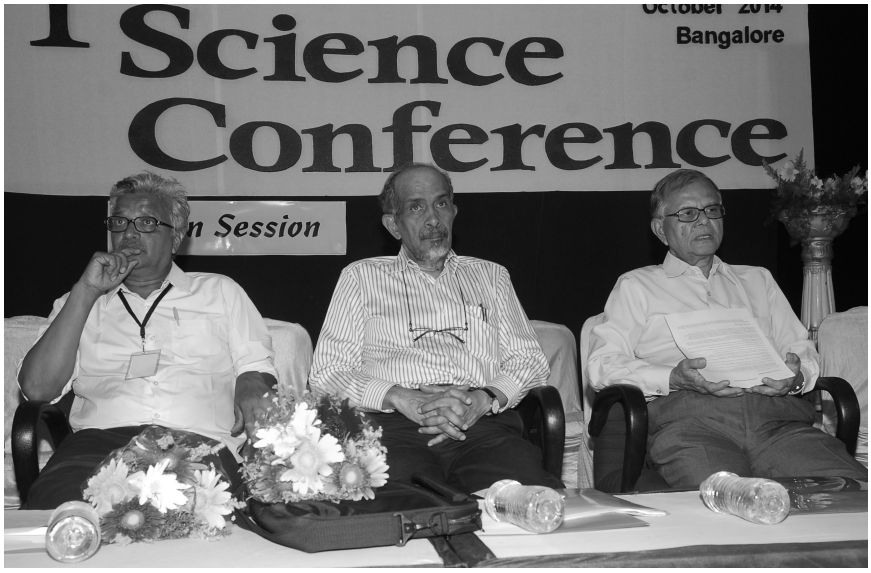
I congratulate Breakthrough Science Society for their dedicated work in the cause of education.

C. N. R. Rao
National Research Professor
Linus Pauling Research Professor
and Honorary President
Jawaharlal Nehru Centre for Advanced
Scientific Research, Bangalore, India

Message from Prof. Jayanta Kumar Bhattacharjee

PROMOTING SCIENCE IN THE COUNTRY

It is a pleasure to recognize the excellent



The inaugural session. On the dais from L to R: Dr. Manivannan, Prof. Roddam Narasimha, Prof. Dhrubajyoti Mukherjee.

work done by the Breakthrough Science Society to generate scientific culture in the country. I feel that a tremendous barrier to the development of a scientific mindset is the science education at secondary and higher secondary levels. The idea that the world around us runs on scientific principles and that everything that we can see and feel can be understood on the basis of very few principles is something that needs to be stressed endlessly. It is not that it is a new principle for every new phenomenon that you see but a few principles to explain thousands of phenomena. The exercise in logic that allows one to do this should be the central theme of science education Vthe appreciation of this logic would help people to accept science as a way of life. Science as GK should be totally discarded. The Breakthrough Science Society has been active in expounding the logic in science and this will eventually create a more rational society.

Jayanta K Bhattacharjee
Director
Harish-Chandra Research Institute
Allahabad

Message from Prof. Rajesh Gopakumar

Dear Friends,

My greetings to all of you who are present at this All India meeting organised by the BSS. I am very happy to see that there is so much momentum for three days of discussions on science education and scientific outlook. I am sure this will create a positive impact on society.

Our society today is very happy to use (and misuse) the fruits of science but very reluctant to cultivate the scientific temper that is part and parcel of the practice of science. As a society we are often too impatient to sift out true facts and discard myths. We are often too self-righteous to listen to alternative points of view and to tolerate diversity of thinking. Too often, he who shouts loudest or threatens violence gets his way. In schools, we try to stifle the enquiry of young minds and get

them to parrot received wisdom. All these are the anti-thesis of a scientific outlook on life which our constitution enjoins us all to cultivate. I hope scientists and their well-wishers will take initiative, individually and collectively, to bring about a change of mindset in the populace.

I was very heartened by the response of the scientific community, as well as the public, during the campaign for the Maharashtra Anti-Superstition Bill. Over six hundred scientists and more than a lakh citizens added their voice to this demand which made a positive impact on the Maharashtra legislators which finally passed this bill, for which Shri Narendra Dabholkar had fought all his life and for which he was cruelly assassinated. I now hope that this success will give impetus to other states, including Karnataka where your meeting is being held, to pass similar bills paving the way eventually for an All India version. This is a worthy concrete goal to keep in mind in your discussions. My very best wishes to your gathering for a fruitful and stimulating meeting.

Rajesh Gopakumar
Professor
Harish-Chandra Research Institute
Allahabad

Message from Dr. Arvind Gupta

We have a rather provocative slogan: *The best thing a child can do with a toy is to break it.* Children need to touch, feel, taste, pull things apart, assemble them back before they develop a deeper understanding of science. Children's learning starts from the concrete and goes to the abstract. They learn best through activities and material which are low-cost, ordinary and readily accessible. Our team has documented over a 1000 such activities using old newspapers, straws, paper cups, matchboxes etc.

Dr. R. Manivannan placing the wreath in memory of the Heroes of Science.

We have more than a 100 activities using throwaway plastic bottles. I would urge all participants to go through the website http://arvindguptatoys.com

This august gathering must contribute more ideas, so that someday we can have a national repository of the best science learning aids. The Western models are very expensive and unsustainable. We need to develop appropriate teaching aids to help the poorest children across the world.
Love and peace,

Arvind Gupta
Famous popularizer of science

Organizational Report

The dismal state of rationality and scientific bent of mind in a major part of the population in India had been causing anguish in the science-loving people of the country for quite some time. The idea of initiating a

Panel discussion on "Why the present scientific education is not developing a scientific bent of mind?." From L to R: Dr. Ganesh Bhatta, Prof. Dhrubajyoti Mukherjee, Prof. P. N. Thankachan, Prof. S. Mahadevan, and Dr. B. S. Shylaja.

science movement to address the problem nucleated in the early 1980s at the insistence of the eminent scientist and former Vice-Chancellor of the Calcutta University, Prof. Sushil Kumar Mukherjee. The science magazine Breakthrough made its first appearance in November 1984 as a medium of propagation of the idea, with Prof. Mukherjee as the Chief Advisor.

Slowly activities started nucleating in different parts of the country. In the state of West Bengal, formation of science clubs started in different districts, towns, and localities. When the number of people and science clubs associated with Breakthrough reached a critical mass, it was decided to give it an organizational shape. The Breakthrough Science Society (BSS) came into existence as an organization through an All Bengal Science Conference held from 30th December 1994 to 1st January 1995. Subsequently the new organization was registered under the West Bengal Societies Registration Act. In the other States activities continued through somewhat informally formed "Chapters" of Breakthrough Science Society or through science clubs working in close association with the BSS.

After continuing in this mode for 19 years, it is now felt that the activities and the number of people associated with the BSS in different States have reached such a level that it is now possible to formally give it the shape of an all-India organization. This conference is being organized with this express objective.

Over the years we have developed different types of programmes in tune with the aims and objectives of the BSS. We try to popularize scientific astronomy to counterpose it against beliefs in astrology. For this, we regularly organize skywatching programmes and slide shows on astronomy. We have organized large-scale observation of important astronomical events like the total solar eclipses of 1995, 1999, and 2009, the arrival of Comet Hale-Bopp in 1997, the Leonid meteor shower in 1998,

the transits of Venus in 2004 and 2012, etc. We devise low-cost and no-cost science experiments, train volunteers to demonstrate them, and organize workshops and experiment shows in schools. We organize nature study camps to make students interested in observing nature. We conduct anti-superstition campaign through miracle-busting shows. We try to cultivate the life-struggle of great scientists to inculcate a sense of value among those who study science. For this purpose we observe the birth-centenaries of scientists, and other scientifically significant occasions. With this objective, we organized year-long observation of the 300th year of Newton's Principia Mathematica in 1987, the Einstein year in 2005, the 150th anniversary of the publication of Darwin's Origin of Species in 2009, etc. In the event of the Orissa super-cyclone, the Gujarat earthquake, the Aila cyclone in the Sunderbans, and other such natural calamities, we have mounted large-scale relief efforts. We also launched movement against the installation of missile testing facility in Baliapal in Orissa, and against installation of nuclear power plants in various parts of the country.

Hundreds of programmes of different types have been organized in different States over the past 19 years, as recorded in the reports published in Breakthrough. Therefore without going into the programmatic details, we are presenting below an objective assessment of the current state of organization in different States.

West Bengal

In West Bengal, the BSS functions as an affiliating organization, with science clubs as the functional units through which different programmes are executed. In educational institutions the functional units are the "Chapters". At present there are 87 science clubs affiliated with the BSS, and the district-wise distribution is as follows: Kolkata – 10, Purba Medinipur – 11, Paschim Medinipur – 14, Purulia – 4, Bankura – 4, Burdwan – 6, Howrah – 5, Hooghly – 6, Birbhum – 2, Murshidabad – 2, Nadia – 2, North 24 Paraganas – 6, South 24 Paraganas – 8, South Dinajpur – 1, North Dinajpur – 2, Jalpaiguri – 4, Coochbehar – 4, Darjeeling – 2. Since the formation of the BSS in 1995, State Conferences have been held once every 4 years. The last conference was held in the year 2012 where the current state committee was formed. In the Purba Medinipur, Paschim Medinipur, Kolkata and Howrah districts of West Bengal, district coordination committees or steering committees have been formed. At present affiliate members from the science clubs constitute the bulk of the membership of BSS West Bengal Chapter. The number of individual members is 180, and the number of affiliate members is about 800.

A few activities are worth mentioning here. After it was reported that 9 districts of the state are arsenic affected, our activist Dr. Nikhil Jana developed a method of detecting arsenic in groundwater, and for many years our volunteers went to remote locations every weekend, installed makeshift laboratories, identified the affected tube-wells, and campaigned to apprise people of the dangers of drinking contaminated water. We also created a laboratory in Kolkata for augmenting this effort. These activities gave rise to a people's movement, and the government was forced to arrange for alternative sources of drinking water in most of the affected areas. We launched large-scale campaign to make people observe the total solar eclipses of 1995 and 2012, the transits of Venus of 2004 and 2012, and many other astronomical events. During the 1995 eclipse, 27 "ob-

servation Centres" were created from which about 10000 people observed the event (and took food during the eclipse). The observation of the Einstein year in 2005, Darwin year in 2009, the 150th birth anniversary of Acharya Prafulla Chandra Ray in 2011, the birth centenary of Prof. Sushil Kumar Mukherjee in 2013 and other such events gave us an opportunity of cultivating the life and struggle of the great men of science. The last two were observed through subdivision, district, and state-level science competitions where thousands of students participated. After the discovery of the Higgs-boson particle, we felicitated the Indian scientists involved in the CERN project.

Karnataka

The BSS has been active in Karnataka for the past 15 years and many successful programmes have been conducted. Organisations exist in Bangalore, Gulbarga, Raichur, Mysore, Dharwad, Davangere, Chitradurga, Bijapur, Bellary, and Tumkur districts. The Chapters in Bangalore, Gulbarga, and Raichur are quite strong. Many programmes have been organized in Dharwad, Davangere, Chitradurga, Bijapur, Bellary, and Tumkur districts also. District conferences have been conducted in 3 districts: Bangalore, Gulbarga and Raichur. The Bangalore, Gulbarga, and Raichur District Committees have 28, 30, and 9 members respectively.No science club is currently associated with the BSS, the State and district units function as Chapters of BSS. There are around 100 activists and organizers across the state and around 3000 members.

The State Chapter has a unique feature of organising creative programmes like science dramas, Science fest, miracle busting shows, food adulteration detection, apart from annual Science Camps and Chart and quotation exhibitions, etc. There is fluoride pollution problem in the Kolar, garbage disposal issue in Bangalore on which BSS can organize movements. The issue of environmental protection in the Western Ghats can be jointly taken up by the Karnataka and Kerala Chapters. Recently a very successful state-level Science Fest was organized in Bangalore which generated much interest and was visited by more than 10000 students and science loving people.

Kerala

From the year 2000 onwards, the Breakthrough Science Society has been working in Kerala. The activities gained momentum during the transit of Venus programme in 2004. District-wise activities started during that period. Organizational expansion occurred during the observation of the Year of Physics in 2005. The Kerala chapter produced a documentary, a photo-poster exhibition, and a book on Albert Einstein and the Theory of Relativity. District-wise activities have started in Thiruvanathapuram, Allppuzha, Kottayam, Kollam, Pathanamthitta, Ernakulam, Palghat and Kannur districts. District BSS chapters were constituted. The subsequent observation of the International Astronomy Year in 2009, the Darwin year in 2009, the Year of Chemistry in 2011 provided opportunities for organizational expansion, which were fully utilized. Every year during July 4th, observation programmes are taken up in many parts of Kerala. Astronomical programmes like the Transit of Venus in 2012, the solar eclipse in 2012, the visit of Comet ISON also provided great opportunity. Before the Transit of Venus in 2012, a Malayalam book was published.

The Kerala Chapter became a registered organisation in 2013. In 2012 a 16 inch telescope built by Shri K. Thankappan was installed in the Giordano Bruno Observatory at Harippad. The association of some

Prof U R Rao addressing the delegate session.

of the public/Govt. Institutions with BSS is to be specially mentioned. In Thiruvanathapuram, the Kerala Science and Technology Museum associated with us on many important observations like the transit of Venus, solar eclipse, etc. We conduct month-long vacation science classes during every summer in the Museum. In Kottayam for the last 7 years Jawahar Balbhavan and children's library are associating with us. The Astronomy Club working at Balbhavan had been organising monthly programmes for the last 7 years. Many organisers evolved from the activities of the said Astronomy Club. Netaji Socio-Cultural Centre, Harippad in Allappuzha, is another organisation to be mentioned; the Giordano observatory is situated in this centre. A large number of camps had been organised at the Netaji Socio-Cultural Centre. We have free entry into many education institutions in Kerala, especially in Kottayam, Thiruvananthapuram, Pathanathitta, Allappuzha and Ernakulum. Many of these institutions contact us for anything related with science and having popular science nature. Local science clubs affiliated to BSS are working in Palghat, Kottayam. The number of membership is about 100. The membership drive has just started. The weakening of Kerala Sastra Sahitya Parishath, once a chieftain in Kerala science movement, has left a void which the BSS is fast filling up.

Odhisha

In Odisha BSS work was started under the banner of "Bigyana Chetana Mancha, Odisha"; for historical reasons this name has been retained for the Odisha BSS Chapter. There is a State body and also district level and local committees. State level conference has been held and a State Body has been elected, which takes care of the science activities in the State. There were about 300 enrolled members in 2012 but the membership fell during later years. In 2013 and 2014 there were about 50 members. There are 15 life members, most of whom are reputed scientists/educationists/researchers. Bigyana Chetana Mancha works in Barampur, Khurda, Cuttack, Kendrapara, Puri, Jajpur, Bhadrak, Balasore, Sundargar and Balangir districts of Odisha. In the dis-

tricts of Cuttack, Puri, Jajpur and Balasore there are fairly regular activities and in other districts mentioned above, science programmes are conducted somewhat irregularly. Potentiality for the expansion of the science organisation is very good in all the districts and there are science activists in these districts.

In Odisha, the major hindrances to the movement for building up a scientific temper are the existing superstitions regarding various natural phenomena. Among the tribal population the practice of black magic with killing in the name of 'Dahani' is still continuing. Awareness programmes in those tribal areas is very urgent as scores of people get killed every year in this way. Odisha is often devastated by calamities such as floods and cyclones. Therefore, it is necessary to build up movements so as to educate people and minimize their impact on human life and property. Environmental pollution due to mining and other activities is a major problem in different parts of Odisha. Scientific study on their impact on human beings, flora and other fauna needs to be taken up and movements involving the affected rural and tribal population need to be taken up in right earnest.

Bihar

Chapters of BSS have been operational in the Patna and Darbhanga districts for quite some time, and many programmes have been organized. There are two science clubs in Patna, called the Galileo Science Club and the Raman Science Club. Another one, called Adarsh Science Society, has been formed recently. An Einstein Science Club is functional in Jamalpur town in the Mungher district. There is a good scope of starting BSS Chapters in Bhagalpur, Muzaffarpur and Vaishali districts. A state level workshop was held on 28 Sept. 2014 in Patna, where a state levelorganizing committee was formed with Kamal Kishor and Rajiv Kumar Sharma as Joint Convenors and 12 committee members. Membership drive has not yet been launched in the state.

Uttar Pradesh

There are functional organizations in the Allahabad and Lucknow districts. The district-level conference has been organized in Allahabad on 9th February 2014 and in Lucknow on 3rd October 2014. District committees have been formed in these two districts. The State conference was held in Lucknow on 15th September 2014, and the Executive Committee of the State Chapter has been formed. There is no science club in the state as yet, but the Executive Committee has plans of organizing clubs in a few localities in near future. There are activities in the districts of Ballia, Kanpur, Mau and Sultanpur, but it has not yet been possible to give a definite organizational shape to these activities. Possibilities exist to build up organizations in the Balrampur, Gonda, Ghazipur, Jaunpur and Raibareli districts. The number of members is around 60. The main problems in the state are communalism, politics based on caste and creed, and prevalence of superstitious beliefs, which need to be countered with the science movement. But these are also the main hindrances in the path of creating a science movement.

Tamil Nadu

In Tamil Nadu, science activities are being carried out in Madurai, Theni, Salem, Neyveli, Villupuram and Chennai districts. The State level conference was organized on Sept 13, 2014. The newly elected state body has an advisory panel consisting of professors and scientists who are already involved in various science education and

popularisation activities. They are also well known among the science loving people of the State. District level conferences are planned to be conducted after the All India Conference. So far the effort to initiate science clubs has not started, but the Executive Committee of the State Chapter is planning to form science clubs in a few colleges and schools after the All India Conference. As of now there are 75 members in the state. The membership campaign is on. The important issues in the state that need serious study and appraisal are: (1) Water management (for irrigation and drinking), (2) Environmental hazards posed by power stations (Coal and Nuclear) and theMethane project in the Cauvery delta. In the wake of the people's movement against the Kudankulam Nuclear Power, at the initiative of BSS a People's Committee for Safe Energy (PECOSE) has been formed and a National Convention was held at Chennai on April 6, 2013 on "Approach to the Power Question in the Country". Many distinguished scientists, planners and engineers participated in the programme.

Andhra Pradesh and Telengana

Breakthrough Science Society has organization in 5 districts. In Hyderabad district regular activities are going on. In other four districts there are some activities, but somewhat irregular in nature. District-level conference has been held in the Hyderabad district, and a committee has been formed. There are four institutional level science clubs. Membership drive has not been launched yet. There are 10 regular activists, and 10 part-time activists.

Jharkhand

There are 5 science clubs associated with the state organization: the Einstein Science Club, C.V. Raman Science Club, Madame Curie Science Club, S.N. Bose Science Club, and the Discovery Science Club. The State Conference has been held on 6 Sept 2014. There are 45 members in the state Chapter, and around 110 members of the affiliated science clubs, who are also members of the State Chapter, though this has not been formalized yet. Until now there is no district organization but the above mentioned clubs are functioning under the guidance of State body. Environmental pollution in cities like Jamshedpur, Dhanbad, Bokaro, and Ranchi, and the nuclear radiation in the uranium mining areas of Jadugora, Narwa etc. offer scopes of building up movement. Superstitious beliefs are very prevalent in the rural areas and interior villages. Women are being killed after branding them as witches. These should be the focal points of science movement in the coming years.

Madhya Pradesh

There is organization in mainly two towns: Guna and Gwalior. District conference has been organized in Guna, and a committee has been formed. Many successful programmes have been organized in both the towns. There is also possibility of organizing activities in Bhopal and Indore districts.

Delhi

Even though many programmes have been organized in the national capital, an organization has not taken shape yet. The centre of activities lies mainly in the Delhi University, where the prospect of forming a BSS Chapter is quite bright. The city has many issues like contamination of drinking water, lack of proper drainage, etc., on which popular movements can be organized.

The other states

In the states of Gujarat, Assam, Tripura, Haryana, and Punjab quite a few programmes have been organized in the past, but an organization has not yet taken shape. In all these states we have contacts and activists, and the possibility of forming BSS chapters is quite bright.

Books published

The BSS has so far published a few books and booklets in different languages:

1. Science and Society – by Prof. Sushil Kumar Mukherjee (English)
2. Seminal Thoughts (English)
3. Evolution through ages (Bengali)
4. Giordano Bruno (Bengali, Oriya, and Hindi)
5. Arsenic Pollution and its remedy (Bengali)
6. Comets (Bengali)
7. Acharya Prafulla Chandra Ray (Bengali)
8. Leonid meteor shower (Bengali)
9. The importance of the discovery of Higgs boson (Bengali)
10. What we need is a new science movement (English, Bengali)
11. The Second Green Revolutiona review (Bengali)
12. Transit of Venus (English, Bengali, Hindi, Kannada, Malyalam)
13. Year 2012: Will the world come to an end? (English, Bengali, Kannada)
14. Story of the evolution of the solar system (Tamil)
15. Marie Curie (Oriya, Telugu)
16. Miracles and rebirth (Kannada)
17. Albert Einstein and the Theory of Relativity (Malyalam)
18. Darwin and the Theory of Evolution (Malyalam)

The resolutions adopted at the conference

Condolence Resolution

The first All India Science Conference organized by Breakthrough Science Society deeply mourns the demise of Prof. Sushil Kumar Mukherjee, former VC of Calcutta and Kalyani Universities, former Director of the Bose Institute, and a soil scientist of international repute. He breathed his last on 18th November 2006 at the age of 93 at his Kolkata residence. He was the founder Chairman of the Advisory Board of Breakthrough, the journal on science and society, and perhaps the last icon of the Indian renaissance movement. Breakthrough started its journey with the valuable advice and guidance of Prof. Mukherjee. Breakthrough Science Society will always remember his leadership and guidance to build up a new science movement in the country. His demise is a great loss for the society.

This conference also mourns the sudden demise of Prof. P. K. Ray, former Head of the Department of the Civil Engineering and former Registrar of B. E. College, Shibpur, West Bengal. He was the working President of the BSS West Bengal Chapter. Prof. Ray breathed his last on 11th September 2014 at the age of 71.

This august house deeply mourns the untimely demise of Dr. Subhasis Maity, a founder member and one of the Vice-Presidents of Breakthrough Science Society, West Bengal Chapter. Dr. Maity was

suffering from stomach cancer and expired on 3rd October 2013 at the age of 51 years. His innovative ideas, his expertise in astronomy, and his dedicated service helped the BSS to grow in many ways. The void left by his absence will be difficult to fill.

The All India Science Conference is deeply shocked at the ghastly assassination of Dr. Narendra Dabholkar, a reputed leader of the anti-superstition movement in Maharashtra on 20th August 2013. His sacrifice for the cause of developing scientific attitude and bent of mind among the people will be remembered with deep respect. This august house vows to carry forward his noble mission further.

Finally this house mourns all of those who had laid down their lives for the cause of science movement, and observes one minute silence to pay respect to them.

Resolution on safe energy and protection of the environment

India is rich in natural resources like coal, water, gas, wind and solar energy. Every source of energy has its associated problems and risks. So a judicious mix of the different energy sources available in the country should be made use of. The criterion to opt for a particular source of energy should be based on whether it is safe, economical, and pro-people. The objective of the energy policy should be to make electricity reach every household of the country and to satisfy the power requirements of agriculture and industry sectors in a sustainable way causing minimum disruption of the environment.

Presently coal is the workhorse of Indian power sector. But it has its associated environmental hazards. Appropriate measures must be taken to minimize pollution in coal based power stations by adopting clean coal technology. Gas is less polluting than coal and Combined Cycle Gas Turbines greatly enhance the efficiency of thermal power stations. The dependence on fossil fuels can be reduced by increasing the share of renewable sources, by minimizing the distribution losses, and by energy conservation measures. Some planners and also the Governments are citing the problem of pollution from fossil fuel based power plants to bolster the argument that we should go in for more nuclear power generation and that too by importing reactors and fuel. The nuclear option is not only costly but there are serious hazards associated with it, particularly from the highly radioactive wastes. The recent Fukushima nuclear disaster in Japan is a testimony to this. This is the reason many of the advanced countries are giving up the nuclear option.

This Conference is of the firm opinion that we should rely more on renewable and sustainable resources including sun, wind, mini- and micro-hydel power; evolve an integrated power policy based on cost-benefit analysis and energy conservation measures which would resolve the power shortage problems to a very large extent. This should be combined with decentralized and distributed generation for renewable energy. The government should allot greater funds for development of appropriate technologies for generation of power from these sources instead of spending disproportionately on setting up nuclear plants as it is doing today. The government should also set up institutions for research on renewable and sustainable energy technologies.

This Conference firmly opines that any policy decision concerning the lives and livelihoods of the people must be evolved through direct consultations with the concerned people and should be implemented with their consent and should not be arbitrarily imposed.

This Conference notes with concern that yielding to pressures of industrialists for

The first session of 18 October. From L to R: Prof Soumitro Banerjee, Prof. U. R. Rao, Sri Nagesh Hegde.

making bigger profits, the Union Environment Ministry, through a quick series of notifications, has eased the rules for mining, roads, power and other industrial sectors. It has diluted a host of regulations related to environment, forest and tribal rights. Possibly the most far-reaching change that the government intends to bring about is an overhaul of the five main environmental laws of the country – the Environment Protection Act, the Forest Conservation Act, the Wildlife Protection Act, the Water (Prevention and Control of Pollution) Act and the Air (Prevention and Control of Pollution) Act. The Environment Ministry has set up a committee to review these laws and recommend amendments and make them more "industry-friendly." This Conference strongly protests this move for diluting the laws that protect the environment, biodiversity, wildlife, and life and livelihoods of the people in the name of industrialization and demands that the brazen flouting of the environmental laws by the corporate houses be strictly dealt with.

Resolution on the Science, Technology, and Innovation Policy – 2013

During the period of our freedom movement, in spite of the limited resources for research, India could produce great scientists like J.C.Bose, P.C Ray, S. Ramanujan, C.V Raman, M.N.Saha, S.N.Bose, and several others whose path-breaking contributions in the field of science were recognized worldwide. Our resources for scientific research have increased during the post-independence period. While the volume of research output has increased in absolute terms, we seldom, if ever, come across similar path-breaking work from scientists in India in the 67 years after independence. The policies on science and education pursued by the successive governments after the independence have played a major role in taking the country to this state of affairs.

Scientific research thrives in a conducive environment. During the period of our freedom struggle a sense of idealism motivated the young minds engaged in research. A de-

The Presidium of the Delegate Session. From L to R: Mr. G. Satish Kumar, Prof. Soumitro Banerjee, Prof. Dhrubajyoti Mukherjee, Mr. Subrata Gouri, Mr. G. S. Padmakumar, Mr. V. P. Nandakumar, and Mr. Debashis Roy.

sire to serve the country by advancing the frontiers of knowledge and thereby bringing material and cultural benefits to the people fired their zeal for research. In tune with this the leaders in our renaissance movement propagated the idea that education is to be viewed as a tool to free the human mind from all types of bondage, and raised the demand that education must be accessible to all and that the state should bear all the expenses of education up to the highest level. However, the successive governments of the post-independence period totally ignored this demand, and instead followed policies which deprived the vast masses of people of access to education. They are now openly following the policies of privatization and commercialization of education, and as a result education has become an expensive commodity in the market unaffordable for the common people. Study of science and scientific research are being increasingly looked upon simply as a tool for getting a job, and building a career. In addition, science is being taught in our schools and colleges with overemphasis on gathering information at the cost of fundamental concepts, completely ignoring its methodological and philosophical aspects. A science education that does not aim at building rational and scientific bent of mind and does not impart an ethical attitude towards practicing science cannot foster high quality scientific research.

Providing adequate funds for the establishment of research facilities is a prerequisite for fostering scientific research. This Conference notes with deep concern that the 'Science, Technology and Innovation (STI) Policy – 2013' unduly emphasizes that research funds are to be mostly generated from private industry, instead of the government fully financing scientific research. It aims to increase the Gross Expenditure in Research and Development (GERD) to 2% of GDP from its current level of less than 1% of GDP with investments from private sector. The fact is that Indian Industry is not interested even in generating its own technology through indigenous R&D because it aspires for maximum profit in a short period, and is con-

tent with importing second-hand technology from abroad. In this situation, linking scientific research with industry funding is bound to be detrimental to the development of S&T in the country. As a direct consequence of depending on industry for funds, research in basic sciences is given less emphasis as it is not of any immediate use to the industry. Path-breaking scientific advancements come from research in basic sciences and not from the industry sponsored research taken up with a limited objective of developing or improving some products. Again, the industry's interest in research depends on market conditions and economic recession results in drastic reduction in industry sponsored research. This conference is of the firm opinion that the government should take full responsibility of funding research and that must be clearly stated in the science policy document. Industry supported research can only be an addition to the government funded research.

We also note with concern that the STI Policy – 2013 intends to "treat R&D in the private sector at par with public institutions for availing public funds." In private sector, R&D is carried out with business motive for earning profit and not for serving social interest. Therefore public funds should not be provided for R&D in private sector. Public funds should be provided to government controlled institutions for facilitating research aimed at improving human understanding of nature and for human welfare. We also deplore the government's policy of spending huge amount of money for defense research, a destructive use of science and technology.

The Science and Technology Policy of 2003 declared as one of its objectives "to establish an Intellectual Property Rights (IPR) regime" and the STI policy – 2013 is committed to strengthen this IPR regime by establishing "regulatory and legal framework for sharing IPRs between inventors and investors." No scientist or investor can treat the knowledge generated through research as a private property, because the scientist could not produce this knowledge without using the existing the body of knowledge generated by the entire mankind. The IPR system restricts the scientists from accessing information, and thereby hinders further development of science. This conference therefore demands abolition of IPR system.

Authoritarianism is another malady that has engulfed our science and technology regime. The absence of democratic culture resulted in establishment of bureaucratic control over the research institutions, a condition highly inimical to the advancement of scientific research. The STI policy - 2013 is silent on this issue. This conference demands democratization of the entire Science and Technology set-up and complete autonomy to the research institutions free from any governmental intervention in research activity and administration.

This conference is deeply concerned about the fact that the science and technology policy of the union government does not address the real problems facing the advancement of science in India. This All India Science Conference organized by Breakthrough Science Society therefore demands the introduction of a new comprehensive Science Policy with the following objectives.

1. To introduce scientific, secular and democratic education and to foster a scientific bent of mind among students to create an atmosphere conducive to the development of scientific research.
2. To stop commercialization of education completely.
3. To teach science with adequate emphasis on fundamental concepts, method of

science and philosophical aspects of science.

4. To democratize the entire science and technology regime and to provide complete autonomy to the educational and research Institutions.

5. To encourage research in the basic sciences.

6. To provide adequate funds for all government-funded organizations of higher education, universities and research institutions for creating necessary infrastructure for research.

7. To increase the gross expenditure on R&D to at least 2% of GDP through governmental funds, not through private-sector funding or Public-Private Partnership (PPP) model.

8. To stop destructive use of science, curtailing spending on defence research.

9. To abolish 'Intellectual Property Rights (IPR)' system and to allow free dissemination of knowledge created through research.

10. To use scientific and technological research for human welfare.

Resolution demanding the adoption of a bill in all states declaring black magic and other superstitious practices as illegal and punishable offence

One of the major hindrances for creating a scientific culture in India is the wide prevalence of unscientific practices for personal gain. Taking advantage of the lack of education and scientific temper among the people, unscrupulous elements make it their profession to hoodwink the people with various kinds of unscientific practices. At present these are not considered to be illegal, and the offenders cannot be punished. Moreover, such practices are widely publicized and advertised in print and electronic media.

Dr. Narendra Dabholkar had conducted a sustained struggle in the state of Maharashtra, demanding that these practices be declared illegal. The Act proposed by him was opposed and was blocked by all the mainstream parties for many years. After Dr. Dabholkar was brutally murdered on 20 August 2013, the Maharashtra government was forced by public demand to table the bill, and it was adopted in the December 2013 session of the Maharashtra Assembly.

This All India Science Conference demands that similar bills should be introduced in all States of India. In particular, we demand that the following acts should be declared illegal and punishable offence:

1. Claiming to perform miracles and defrauding or terrorising people by these claims.

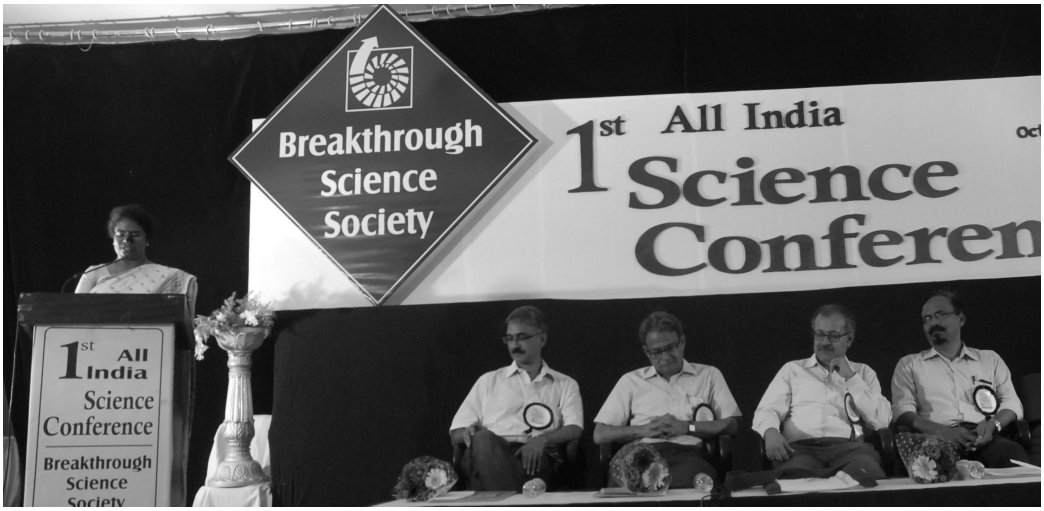
2. Creating the impression that a person has supernatural powers and compelling people to follow his/her orders.

3. Accusing a person of practising black magic or of being a witch, and blaming him/her for causing diseases or misfortune, and harassing and causing bodily harm to the person.

4. Alleging that a person is possessed by ghosts, and assault him/her with the pretext of exorcising the ghosts.

5. Claiming to invoke ghosts, creating the impression of possession, preventing the person from seeking medical treatment, and compelling him/her to inhuman acts.

6. Preventing a person from seeking medical advice in case of dog, snake, or scorpion bite, and inducing him/her to take magic remedies.



The panel discussion on 18 October. From L to R: Ms. Rajani introducing the speakers, Prof. Satyajit Mayor, Prof. Bala Iyer, Prof. Soumitro Banerjee and Prof. Moncy. V. John.

7. Claiming to cure diseases and to change the sex of an unborn foetus, using magical powers or "psychic surgery".

8. Carrying out or encouraging acts which endanger life or cause grievous injury in order to gain supernatural blessing.

9. Claiming a mentally ill person to have supernatural powers and using such a person for personal gain.

It should be noted, however, that mere enacting such a law will not eradicate these superstitious practices from the society. A powerful science movement only can achieve that end. The enactment of the law will act as a deterrent, and will help the science movement by not permitting the perpetrators of such crime to be shielded by the law enforcing agencies. If law declares such unscrupulous hoodwinking of the people as illegal, progressive minded people and science workers working in the localities will have law on their side when confronting such people.

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A MESSAGE

Krishna Chakraborty

Mr. Krishna Chakraborty, an Advisor of the Breakthrough Science Society and a well-wisher, was to address the newly elected National Executive Committee and the General Council with the guideline as to how the BSS ought to work in future. Unfortunately, the sudden attack of serious illness had confined him to the Hospital, and he could not attend the Conference. However, he took the trouble to send a message for the delegates which was read out at the Conference. We are sure that this would work as a guide to action for the workers of BSS. — Editor

Dear President and Newly Elected Members of the Council of Breakthrough Science Society,

I had a deep desire to be physically present in this historic Science Conference of yours. But unfortunately, I was suddenly laid down by a severe viral attack and had to be shifted to the hospital. It is still not certain when I would get discharged. Hence this written message.

A science conference of this kind that you have organised with the renowned scientists, research scholars, science students and people interested in science and a conference with the aim of truly practicing science, developing scientific attitude and method of thinking and for cultivation of human values that only science can show to us, is no doubt a unique venture.

This no doubt is a noble endeavour at the same time, particularly, when true scientific bent of mind, method of study and cultivation of higher human values have become rare not only in our country but in the whole world. I am constrained to say that such qualities can hardly be found even in those who are seriously engaged in studying sciences. Naturally, it is a noble struggle, but a very difficult challenge at the same time.

You know the history of development of modern sciences. It started from the middle of the fifteenth century, with Copernicus. Science had to develop in a very hostile environment when Giordano Bruno was burnt alive because of his pursuit of science and his fight against established religious beliefs. Almost similar was the fate of Galileo who also had to face inquisition. No great struggle of the world has developed in favourable condition so far. It had to face stiff opposition from the ruling class and most conservative religious heads who feared science. In feudal conditions of life vast majority of the people were victims of prejudices, superstitions and obscurantist ideas. Blind faith was the greatest obstacle to the struggle not only in those days but also for the present as well. The bourgeoisie who in the rising period of capitalism fought for development of social production and for that had to fight for the development of sciences are afraid of science today in the period of over production due to lack of market. So, even today the most powerful section of the society that is the bourgeoisie who rule are the greatest en-

emy of science. Why? It is because science tells the truth. Science shows everything changes and changes from quantity to quality, from the lower to the higher. You should always keep in mind that in this material world nothing is permanent, nothing is absolute, nothing is all perfect. Of course at a given time there is a highest development of a thing. But with change of time it becomes inadequate and imperfect. In course of change and development, reaching its nodal point, again it undergoes radical change. No phenomenon can avoid this process. The bourgeoisie also knows that capitalism also must go. And they fear this very truth.

There is a popular saying as well as a belief even within the educated section of the people because of long and vicious propaganda, that science may give worldly goods but cannot deliver peace of mind or solace. If you analyse this motivated propaganda or belief of ignorants, you can easily see that nothing can be more dangerously misleading and confusing than this. The fact is that man finds peace of mind only when he comes to know the truth. But truth of what?

Truth of the material world. What do we mean by truth of the material world? Material world means nature, society and thought in their correlation and integration.

All branches of science have proved beyond doubt that nature is infinite and will go on changing and developing infinitely. Nothing can exist beyond nature, nothing is therefore supernatural. Again this material world is governed by objective laws. This material world existed and will go on existing independently of human consciousness. Even when man was not born, nature existed and was governed by objective laws. Man tried to know this material world from the very beginning, even when he was in primitive society and his thinking was also primitive. In course of millions of years of struggle man found an instrument, science, to know the material world and its reality. And that method is a systematic analysis of anything on the basis of observation, experimentation and verification. Firstly, science does not accept anything to be true unless it is experimented and verified in a scientific way. Secondly, it believes that this material world is governed by objective laws. This objective material world is governed by objective laws meaning that laws do not exist because of man's likes or dislikes. Thirdly, it believes that these objective laws can be known only by following this process of analysis, observation, experimentation and verification and by no other means.

Those who think that science cannot bring solace to mind, what process do they follow to know the truth? The fact is that they do not have any process. They blindly believe in the sayings or predictions of great men. But however great a man can be, he cannot find truth simply by meditation or 'heavenly power'. And their findings can hardly be experimented and verified.

Friends, you shall never forget that only truth can give peace and solace of mind and establish justice in this society. Those who tell that science cannot bring solace to mind they also read sciences but believe in some supernatural power. So you will find that many lecturers of science at the universities keep *tilak* or *vermilion* on their forehead and shave their heads at *Tirupathi*. Though all do not do it consciously but still it is a hypocrisy. All branches of science have shown that there exists nothing beyond nature, everything is part of nature or natural. They read these things in books academically but do not believe in them. Their truth lies in blind belief and faith. Blindness brings fanaticism and regimentation of thought. The more the blindness the more the fanaticism, and that lays down the solid foundation for the growth of fascism and

not democracy. You shall never forget that blindness is the enemy of science and so of man.

All should know and remember that in history science could grow speedily and could develop in the most free and open atmosphere where discussions, debates, polemics on the basis of philosophical tolerance were encouraged in the society at the beginning of the Bourgeois Democratic Revolution. But today that very bourgeoisie, being afraid of their very ultimate doom, are gagging the voice of the opponents, killing the atmosphere of debate and discussions, trampling down all democratic norms and values. You must wage determined struggle against it, and fight out this most undemocratic trends and tendencies and ensure free and open exchange of different thoughts, for true democracy that finally gives birth to truth.

One more important condition under which science can develop is secular atmosphere. Bourgeois Democratic Revolution in its initial days fought against all religious fads, supernatural beliefs and obscurantist ideas. One of the great pioneers of renaissance, Jean Jacques Rousseau said that man is born free, but everywhere he is in chains. 'Break the chains, break the fetters' were the slogans of the bourgeoisie during the rising period of capitalism. Now at the dying stage of capitalism, the bourgeoisie has distorted and diluted the concept of secularism which started with non-recognition of any supernatural entity and reduced it to the concept of encouraging all religions. The dialectics of capitalism has forced the bourgeoisie to go against the idea on which bourgeois renaissance movement started. You friends, who are fighting for growth of science should stubbornly fight against this motivated distortion of secularism.

Some are so blind as to say whatever you see today, say aeroplanes, rockets etc., all were there in our ancient India. Modern science has only taken from those things. These people clearly do not understand the difference between mythology and history. There are exaggerations, imageries, fantastic similes, wild contemplations etc., in all mythologies. In Greek mythology some of the Greek heroes could go to the sky with just sandals in their feet. Likewise there are angels and fairies in all fairy stories. Are there truly any angels or fairies in reality?

There are no such things in reality. But they are not totally unreal also. But how to resolve this paradox then? Man cannot think anything which is not there in the material world. Then how could this happen in fairy stories? It could happen because there are beautiful ladies and children and there are birds which fly with their wings and there is desire of man to fly. So in imagination one can cut the wings of the birds and add it to the bodies of the beautiful ladies and children and dream them to be flying.

In this connection, I would like to tell you a fact that happened in my life. In Chennai, one gentleman who belonged to rationalist movement attended one of my discussions. He was so impressed that after the discussion he met me and presented one of their publications. Next, when he met me he asked me how I liked that. I told him, 'If you do not mind I could not appreciate your logic. You try to prove that the Hanuman could neither carry the hill on his hand nor could he put the rising sun under his arm pit far less could it make a jump to reach Lanka crossing the sea. I would not have read *Ramayana* or *Mahabharata* unless there were some such things in them.' While the rationalists ridicule these things, the vast majority of our people blindly put faith on them, believing that those feats could be really performed by *Bajrangbali*. Both the sections took things in extremes, none of them could understand

that this was the form of art of writing epics of those days.

However, the propagandists of old Indian heritage relate those 'achievements of the past' with national heritage. They are so ignorant of the historical development of society that they do not know even this preliminary thing, that, not to speak of Vedic age, even during feudalism there were no nation anywhere in the world. Nation is the product of Bourgeois Democratic Revolutions like the French Revolution, the Industrial Revolution of England, the American War of Independence etc. or the freedom movement of our country. We became a nation after 1947. Before that, though there were many nationalities, there was no nation in India. The nation was in the making during the freedom movement.

These people talk of old national heritage, glorify the achievements of the past so much so that they do not look to the future but look to the past. They propagate that our Vedic science is a great science. So all should learn Vedic science, Vedic mathematics etc. A vast section of the people blindly believe in this. They say in the past we were so great, we had everything. They say what is there to learn from the Britishers, we were so great that when we were in great civilization they were in the jungle. You perhaps read some of the works of great novelist Sarat Chandra Chatterjee. He was not just a great novelist: great novelist he was of course, but a philosopher as well. He understood that this idea of so-called old national heritage will make our students and youths blind and fanatic and thus will obstruct the growth of their intellectual and cultural ability. They must have scientific approach to history. This is why addressing the students and youths in one of his speeches he said, "I do not feel any pride to loudly declare we were so great — 'you the Britishers are nothing in comparison to our old civilization.' In reply to that if the Britishers say that if you were so great then why you were once under the feet of Huns, then the Pathans, then the Moghuls, and now under our feet? Then also I feel ashamed to dig out the history of the past and say you Britishers, you were also under such and such peoples one day. I say Britishers you are great. You have built up a great civilization but we have also all the potentials to become great. This nobody can suppress. Even you cannot."

See the difference between these two approaches! They say go to the past; the past was so glorious. They magnify glory of the past. Can you really go back to the past? Many like to go back to childhood because in the present-day society all-pervading crises, not only economic, political and social but also ethical, moral and cultural, all these together have made life unbearable, suffocating. So we imagine how beautiful was the life of our boyhood and girlhood. No worries; go to the school; if there is rain on the way get drenched in that and ask the teacher to give leave. Then one goes to play and enjoys life. But objectively or historically can we really go back to boyhood or girlhood days? That is a simple and pure dream. That is historically not possible. This is equally true for the society. More so, boyhood and girlhood definitely have potential but are surely not greater than youthful days. Only in youthful days a man or woman can attain very high level, both physically and intellectually. But critically speaking, of course mentally you can go back to past. That means you have made your thinking itself old. Thereby you have made yourself thinking wise and old though you are physically young. That is, your ideas will be the ideas of people of two thousand or three thousand years old. That is not really modern thoughts. That is highly backward, reactionary and not progressive. Again Sarat Chandra Chatterjee says to the youths, in what language can we define

youth and the old age? He says, 'He is old who fears to look to the future, who lives in the past and fears to get dislodged from the past. He likes to spend the last part of his life clinging to the past. Otherwise he feels he would be dislodged in life and become insignificant. Here is the victory of the youths. Youths are those to whom past is nothing more than past. The lessons of the past brighten up their future.' And this is the real and progressive concept of life.

Friends, I know you will not get confused by the confusions of the ignorant or get misled by this reactionary propaganda. Rather you will definitely carry this idea to the vast masses of the people particularly the youths and students who are innocent victims of this mischievous propaganda. This of course is a very blunt propaganda, but there are other propaganda or confusions as well, which are more subtle. Those who do not so bluntly cling as the above mentioned motivated and innocent people to imaginary achievements of mythological stories, some of them magnify true achievements of ancient India as the manufacturing of steel and the mathematics of Aryabhatta or the achievements of Sushrutha in medical science. Those were no doubt big achievements in those days. But, for whatever reasons their ideas could not be advanced further. So they remained backward. What we call modern science did not develop on the findings of those days of India. As I have already mentioned and you all know, this started with Copernicus.

There was an attempt during the first BJP rule at the centre to introduce astrology in the university curriculum. Many believe that astrology is a science. Others who are not that blunt also believe astrology to be a pseudo-science. But the fact is that it is not just pseudo-science it is anti-science. Astrologers believe in fate and fatalism and not in objective material world. In some of my discussions earlier by citing an example I tried to make this point clear. We fear darkness. Why? Because in darkness we cannot see what lies before us. We do not know whether there is a snake or a tiger or a pit or a hole or thorny bushes in the front. So we fear to move ahead. But if we have a torch in our hand that throws powerful light in front of us and brightens it up so much so that even a speck of sand can be clearly seen, then we can easily find out our path and can walk on that boldly. That way man has advanced and built today's civilization with the help of science. No astrology can and neither could achieve it. Because real science throws light on the material world, reveals its hidden laws and thus shows the path, while astrology throws light on our eyes that makes dark future still darker and obstructs our progress.

Lastly, I will tell you about a serious confusion about science. Both the motivated campaigners against science and the ignorant section of the people to which even many academically qualified people like lecturers, professors of the universities belong, believe that science gives us professional knowledge and not ethical or moral sense or concept of values. This is the most dangerous confusion. Actually the correlated knowledge of science has developed, which only can develop, sense of higher ethical and moral principles and value concepts. All branches of science have got their own ethics, so also medical sciences are also having medical ethics.

It shows that science has developed very high sense of ethics of modern times. And those who have truly developed this higher ethics, only they became great scientists, as we see in the cases of Copernicus, Bruno, Galileo, Lavoisier, Newton, Einstein, Marie Curie, Louis Pasteur and others. They all have reflected very high cultural and ethical standards in their personal lives. They had fought against the age-old ethics and value concepts to uphold truth and higher ethics.

For this Copernicus had to suffer whole of his life; Bruno sacrificed his life; Galileo had to face inquisition. And see the ethics of Einstein, he says whatever I take from the society say for example the shirt I use, the food I take all are the products of society and social labour. This obliges me to pay back in equal measure to the society. It is a high ethical concept and a social value as well. Madame Marie Curie could, and in fact was requested by many, to patent her great finding — the radium. This could make her one of the richest persons of the world. But she stubbornly refused it. She desired that this could serve even the needy people. This is a very high social value.

Today when all old value concepts have become totally exhausted, the correlated knowledge of science alone can develop real sense of ethics and social values. Our way of life should be that we practice what we believe in. You should believe in it. Those who read all these ethical concepts from text books but do not believe in them, rather believe in the age-old concepts of ethics and morality, they try to take the country back to that feudal period. But by only fighting this old concepts of ethics and morality and the value concepts and replacing them with higher ethics and morality and social values which are historically developing in social life can we advance our country forward. This is true for all countries of the world.

In this context we should also remember to give recognition to the contribution to human knowledge of any people of any nation which is a high ethical concept. When in blind glorification of so-called national sentiments, we forget the contributions of others, it is highly unethical. The fact is that in the vast field of knowledge of modern sciences and in the other fields of knowledge also Indians have made very little contribution. It demands higher ethics and true modesty to accept this fact. History of development of modern sciences will definitely show to anyone who is freed from prejudices that, except in a few fields of science like the contributions of Jagadish Chandra Bose, Prafulla Chandra Roy, Satyen Bose, Meghnad Saha, C.V.Raman etc., Indians have very few contributions in developing the vast treasure of modern sciences. Only by admitting this fact with all humility, we shall be able to contribute to human knowledge.

We shall never forget that knowledge has no national boundary. Without the knowledge of Copernicus and Galileo, Newton would not have come in history. So also without the knowledge of Newton, the emergence of Einstein would be an impossibility. I have named very few. The emergence of Einstein's thought is the coordination and assimilation of the ideas of very many scientists who appeared before him and during his time. Einstein gives recognition to this fact. He said that today's science could develop only by standing on the solid foundation that his predecessors had laid down.

Another great scientist Louis Pasteur, pointed out that knowledge has no nation or national boundary. Knowledge is the product of the struggle of the entire mankind. Those who narrow down knowledge with national character and confine it within the national boundary, knowingly or unknowingly, they actually obstruct the development of the whole country, while chanting nationalist mantra.

Lastly, man so also animal fight for life against nature. But the difference between the two is basically that in course of struggle, animals can per chance survive, otherwise perish. They are victims of natural laws. But man because of his power of thinking not only survived but has been conquering nature increasingly. This is not because man can change objective laws. Objective laws of nature, society and

thought neither can be created far less can be destroyed. Then how does man change the material world? This is because with the help of science, man has come to know that laws of nature or society work under favourable conditions. Man has known that laws cannot operate under unfavourable conditions. So, man can create favourable conditions in which life grows, society advances. But man can neither create nor destroy objective laws of nature and society but with the help of science, man has learnt that he can create favourable conditions for those laws which help him to grow and develop, so also create unfavourable conditions for those laws which harm the society. Thus, man could create present civilization and will be creating still higher conditions of life with the help of science. Those who do not understand this objective process of development of life and society, they are to know it. But those who oppose this concept virtually obstruct the growth of life and hence are enemies of mankind.

The message may appear to be a long one but I shall not be held responsible for this. Confusions in the field of science are so many and so deep that this could not but take the space. Still then I could not deal with some other minor confusions which also need to be fought out. This I may try in future.

At the end I again congratulate you and not just hope but believe that you would make your science movement victorious.

With best wishes,

Sincerely Yours,

Krishna Chakraborty

Homage

The World Salutes Jonas Salk On his Birth Centenary

George Joseph

ON OCTOBER 28, 2014 Jonas Salk would have turned 100. The world salutes him with gratitude and thanks for his discovery of polio vaccine that has saved millions of children from the tentacles of the virus that would have crippled them for life.

He was born in New York city on October 28, 1914. He attended New York University School of Medicine and on completion of his post-graduation chose to do medical research. In those days, one of the most dreaded diseases in the world was Polio. In the 1952 polio epidemic in the US, the worst outbreak in US history, 58,000 cases were reported in one year out of which 3,145 people died and 21,000 were left with mild to disabling paralysis. U.S. President Franklin D. Roosevelt was the world's most recognized victim of the disease.

In 1947, Salk joined the University of Pittsburgh, School of Medicine and in 1948 undertook a project funded by the National Foundation for Infantile Paralysis to determine the number of different types of polio virus. Salk saw in this an opportunity to work towards developing a vaccine against polio. He along with a dedicated research team struggled hard for seven long years to achieve the goal. The field trial set up to test the vaccine was the most elaborate program of its kind in history, involving 20,000 physicians and public health officers, 64,000 school personnel, and 220,000 volunteers. Over 1,800,000 school children took part in the trial. When news of the vaccine's success was made public on April 12, 1955, Salk was hailed as a "miracle worker" and the day almost became a national holiday in the U.S. Around the world, an immediate rush to vaccinate began. Soon an oral vaccine was developed by Albert Sabin using attenuated poliovirus. Human trials of Sabin's vaccine began in 1957, and it was licensed in 1962. The oral polio vaccine (OPV) is very popular in India nowadays. It is being administered on a mass scale. The two vaccines have eradicated polio from most countries in the world.

Salk should also be remembered for his ethical stand on science. His sole focus had been to develop a safe and effective vaccine as rapidly as possible, with no interest in personal profit. In a live televised interview with Edward R. Murrow on April 12, 1955, he was asked "Who owns the patent on this vaccine?" Salk responded with a line that would become world famous: "Well, the people, I would say. There is no patent. Could you patent the sun?" In 1960, he founded the Salk Institute for Biological Studies in La Jolla, California, which is today a centre for medical and scientific research. His last years were spent searching for a vaccine against HIV. Jonas Salk died of heart failure on June 23, 1995, at his home in La Jolla, California. He will always be remembered as the man who stopped polio.

Homage

OBITUARY

Prof. Gouri Shankar Ghatak

Prof. Gouri Shankar Ghatak, a member of the last Editorial Board of Breakthrough and one of the advisors of the Breakthrough Science Society, breathed his last at the Calcutta Heart Clinic and Hospital after a brief illness. Prof. Ghatak had a distinguished academic career. From his early days at the Presidency College, Calcutta, he developed an abiding interest in science. With the attitude of a true scientist, even at that young age he tried to delve deep into the essence of science, and the philosophy of science. His learning of science was not for scoring marks at the examinations, or for building up a career, but came from his deep attraction for the methods of science and the general principles of scientific analysis and enquiry. Throughout his life he maintained this interest.

After obtaining the M.Sc. degree in Geology from the University of Calcutta, he taught at the Bengal Engineering College at Shibpur, and later at the Presidency College, Calcutta; for a brief period he was at the Durgapur Government College. He was an outstanding teacher, always trying to make the students understand the general principles and the method of science. He could instill in the students' mind a love for science and its rational, analytical approach. His relations with students were open and friendly and he was like their guardian, whom the students could unhesitatingly approach with any problem either in their studies or in their life. His scientific insight, captivating class-room teaching and soft-spoken demeanor endeared him to his students who had a deep respect for him as a scientist, as a teacher and as a person. He served as a member of the expert committees of the UGC, DST etc., and was invited to meetings abroad by foreign scientific societies, but he never flaunted his achievements or attainments.

Prof. Ghatak had a powerful pen and could write equally well in Bengali and English. He started his journey as an analytical writer through his association with the cultural magazines Pathikrit (in Bengali), and Trend (in English). During the centenary year of the legendary Bengali writer Saratchandra, he undertook the herculean task of editing the Golden Book of Saratchandra.

Ever since the inception of our organization Breakthrough Science Society, he was associated with it and played a guiding role. He spoke on many occasions in the All Bengal Workshops organized by the BSS as the lead speaker. In some occasions he spoke in programmes in the other states also. Our organization benefited immensely from his deep insights on diverse topics. The BSS was also immensely benefited by his insightful analysis of many philosophical problems of modern science, including those centring round quantum mechanics, big bang hypothesis, and origin of human consciousness. His demise came at a moment when the BSS has just taken the shape of an all-India organization, and the need for his guiding role is at its maximum.

We pay our heartfelt respect to the departed leader of the science movement. □

A Brief History of Science
Part 7: The Heydays of Mechanical Materialism

Soumitro Banerjee*

THE GREAT UPHEAVAL of science in the 17th century after the millennia of slumber of the middle ages reached its pinnacle in the masterly work of Newton. For a long time Europeans had forgotten to look at the nature around them with eyes of curiosity, and had directed their interest to the divine. The success of Newtonian mechanics in explaining the motion around us, especially the motion of the heavenly bodies, caused a resurgence of materialist outlook. That, in turn, generated interest in understanding various aspects of nature, and led to a condition conducive to the development of various branches of science. People in larger numbers were taking part in scientific enquiry.

However, in the area in which Newton had maximum contribution, namely mathematical mechanics, we see relatively few new ideas added for a long time. His works on mechanics was so exhaustive and comprehensive that scientists in the period following Newton's lifetime found it difficult to add anything substantial to this body of knowledge. It was a period of digestion and assimilation of the ideas he created and their application in different domains. It was only in the second half of the 18th century that Leonhard Euler (1707–1783) and Joseph-Louis Lagrange (1736–1813) and much later William Rowan Hamilton (1805–1865) managed to enrich classical mechanics substantially beyond the Newtonian formulation.

*Dr. Banerjee is in the faculty of the Indian Institute of Science Education & Research, Kolkata. He is the newly-elected General Secretary of the Breakthrough Science Society.

Measuring the solar system

After Newton the heliocentric nature of the solar system and the laws governing its motion were established, but many important details about the solar system were not yet known. What is the weight of the Earth? How big is the solar system? What are the distances to the sun and the moon? What are the radii of the orbits of the other planets? The answers to these obvious questions were not known in Newton's time.

Using Kepler's laws, one can measure the ratios of the radii of the planetary orbits. But unless the true radius of the orbit of at least one planet is known, none of the radii is known in absolute terms. Thus the measurement of the Earth-to-sun distance became a matter of paramount importance. The distance to the moon could be measured using the method of parallax (the change in the moon's position in the background of distant stars when viewed from two different locations). But the same method cannot be applied to find the distance to the sun, because when the sun is glowing in the sky, the background stars are not visible.

Newton's friend Edmond Halley came up with a brilliant idea to measure the distance to the sun. He showed that this can be done only when the planet Venus comes

between the sun and the Earth, which is a very rare incident. During a "transit of Venus," the planet is seen as a small black dot passing across the disc of the sun. The first recorded observation of a transit of Venus was made by the Englishmen Jeremiah Horrocks and William Crabtree in the year 1639. In a paper published in 1726 Halley showed that, if the path of Venus across the sun's disc is observed from distant locations on the Earth and the exact times of contacts with the sun's circumference are recorded, one can compute the distance to the sun from that information (for details, see Breakthrough, Vol.15, No.3, February 2012. The article is available in Breakthrough website).

Halley died in 1742, and the next couple of transits of Venus occurred in 1761 and 1769. In these two years a massive collaborative effort was undertaken by scientists, where they launched expeditions to distant lands across the globe, faced unforeseen hurdles, and recorded the event scientifically. When the data were brought back, the French astronomer Jerome Lalande calculated the distance to the sun to be 153 million kilometres. After this success the distances to the other planets could be calculated easily using Kepler's laws. Cavendish (1731–1810) figured out a way of measuring the weight of the Earth in 1798 using a sensitive torsional balance. Thus, by the turn of the eighteenth century, most of the important information about the solar system was known.

The Industrial Revolution

In the social sphere, capitalism was coming out of the initial phase where production was done in handicraft-oriented manufactories controlled by merchants into one of heavy industry controlled by financial houses. This transformation resulted from the industrial revolution (1760 to about 1830) which benefited from the development of science, and which, in turn, benefited science. The initial onset of the industrial revolution, however, did not depend on the scientific discoveries. Due to a short supply of firewood, use of coal in place of firewood as source of heat started in the manufactories. Technologies necessary for the mining and use of coal had to be developed, which paved the way for path-breaking inventions that changed the course of history. The initial inventions that multiplied productivity came from the working men. In the manufacture of textiles, Hargreaves' spinning jenny (1764), Arkwright's water frame (1769), Crompton's mule (1779), and Cartwright's power loom (1785) first increased the productivity of hand-operation, and then caused the transition from the old hand-operated technique to machines that ran on externally supplied power. In 1709, Darby developed the way of making iron from iron ore using coke obtained from coal (instead of charcoal), which increased the production of iron many folds.

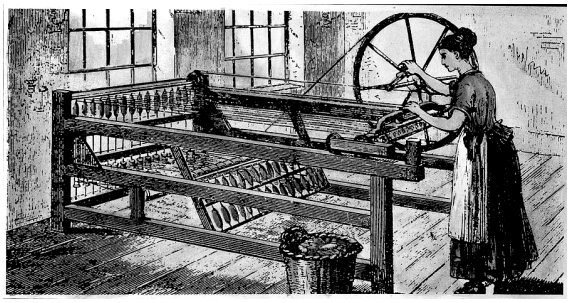

Figure 1: The Spinning Jenny.

Finally, with the invention of steam engine made the decisive break with the old production system. In 1711 a blacksmith called Thomas Newcomen (1664–1729) built the first machine working on steam power. It consisted of a cylinder in which steam was introduced through an in-

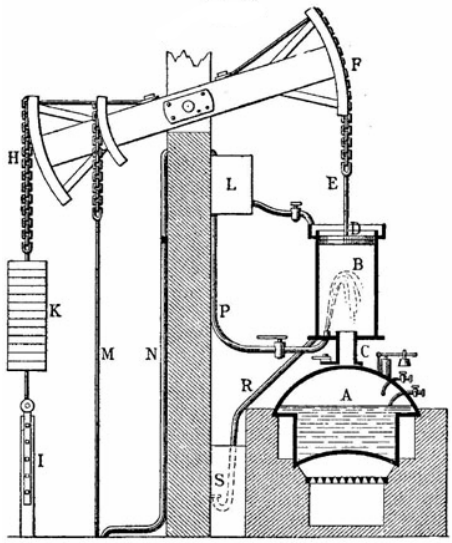

Figure 2: The Newcomen engine.

let pipe, which pushed up a piston. When the piston reached the other end of the piston, the steam inlet would be closed and the cylinder would be cooled with a jet of cold water. This would condense the steam into water and the piston would return to the old position. Again steam would be introduced and the cycle would be repeated. The cycle was slow, but still the machine managed to replace muscle power in water pumping in mines and some other industrial operations. James Watt (1736–1819), the owner of a mechanics shop in Glasgow, improved the design by replacing the condensation inside the cylinder with condensation in a separate condenser chamber which was kept cold permanently by circulating cold water. At the end of the pushing phase an outlet valve would open, allowing the steam to exit to the condenser. He also devised the means for converting the reciprocating motion of the piston into the rotational motion of a wheel. The first working model was produced in 1765, and after a few refinements was released to the market in 1774.

With the development of the steam engine, mankind saw a great leap in industrial productivity. Steam engines could effectively tackle the problem of water accumulation in mines using steam operated pumps. This hugely increased the production of coal to provide a cheap source of power. Cotton mills and other factories quickly adopted this source of power. Iron and steel making started in a big way. Transportation became much faster with the development of steamers and steamships. Railways powered by steam engines were developed in the early 1800s, which could carry much greater amount of goods. New industrial towns like Manchester, Birmingham, Newcastle, and Glasgow — with favourable political disposition and access to water and coal — grew and assumed the centre-stage of industrial activity.

Science comes out of belief systems

We have seen how the development of science was impeded for a long time due to the beliefs in a geocentric picture of the universe and Aristotelian ideas in mechanics, which were overcome through the work of Copernicus, Galileo, Kepler, and Newton. After Newton, the fight with these unscientific notions was gaining victories one after the other. But in many fields the hangover of the medieval style of thinking persisted for quite some time. Imaginary "spirits" were thought to be responsible for many natural phenomena. Heat was thought to be due to the presence of a fluid-like substance called "caloric". Magnetism was explained in terms of a mysterious "essence" — the spirit of magnetism. Burning was thought to be caused by the presence of a substance called "phlogiston"; when a piece of wood burnt, this substance was believed

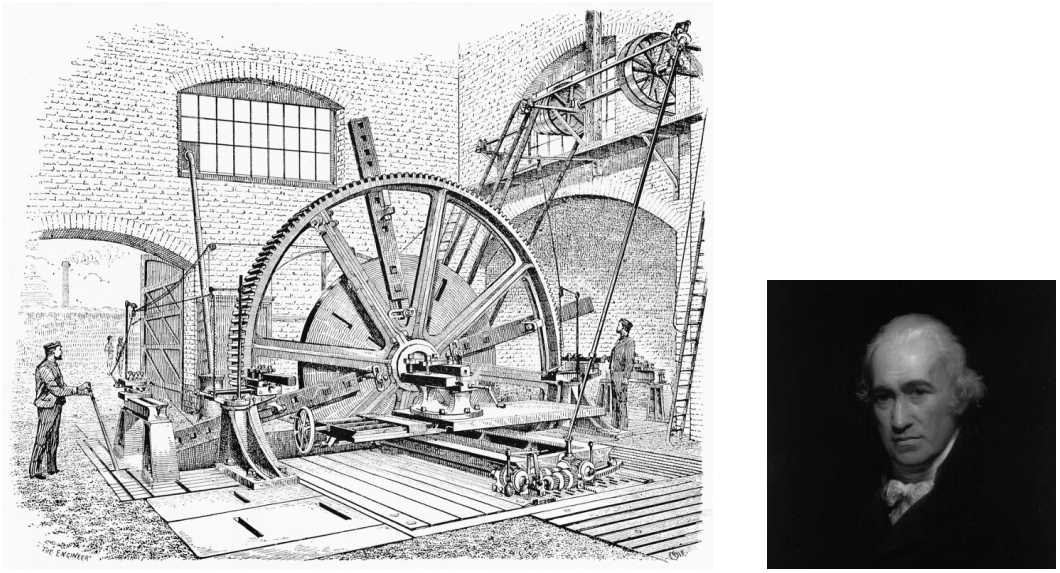

Figure 3: Left: The Watt engine in industry. Right: James Watt (1736–1819).

to be coming out to form the flame. The distinction between living matter and non-living matter was thought to be due to the presence of a "vital force" in the former. Nobody bothered to define what the nature of these mysterious spirits was, and how their presence or absence could be tested. One did not know whether these were material substances which could be isolated, or were particular states of matter. Still these ideas persisted even among capable scientists and impeded the development of science.

The nature of heat

The ideas about the nature of heat started developing only after its practical application was invented, first by Newcomen, and then by James Watt. The steam engine made it apparent that mechanical work could be obtained only by expending heat, and therefore they must be of a similar character. The first indication that "caloric" was not a material substance came from the experiments of Benjamin Thompson, later known as Count Rumford. He argued that if caloric was a material substance, its content must be different in water and ice. To test it, he weighed a piece of ice and the water obtained upon melting it, and found that they weigh exactly the same. This raised the first doubts about the caloric theory. Rumford further demonstrated that when a blunt borer is rubbed vigorously against a cannon barrel, it produced a large quantity of heat that could boil water. But in that process there was no reduction of the weight of the barrel. These ideas were slow in finding acceptance, but when it happened, people realized that heat was not a fluid-like material substance, and was really a form of energy that could be obtained only by expending another form of energy.

The nature of electricity

It was known for a long time that static electricity could be produced by rubbing

Figure 4: Benjamin Thompson (1753–1814).

various substances with silk. Its properties were extensively studied by Coulomb, Cavendish, Galvani, Volta, and Franklin. Big frictional machines were built that could produce very large quantities of charge. Playing with the strange properties of this "frictional" electricity almost became a hobby of many people. Through such investigations, Cavendish (1731–1810), and Coulomb (1736–1806) discovered that the charges were of two types, and that unlike charges attract each other and like charges repel.

Benjamin Franklin's famous experiment with lightning showed that this powerful atmospheric phenomenon that inspired awe and was linked with the rage of gods, was nothing but flowing electricity. Galvani's (1737–1798) serendipitous discovery that a dead frog's legs can twitch when touched with two dissimilar metals led to the idea of current electricity. Alessandro Volta (1745–1827) followed up the observation by experimenting with dissimilar metals dipped in acid or salt solutions, and came up with the idea of the first battery: a pile of zinc and copper plates arranged alternately, separated by cloth moistened with weak acid.

What is burning?

Chemistry was then just coming out of the cradle of alchemy. The alchemist's random experiments in search of a process that could transform different substances into gold yielded some knowledge about the experimental techniques. But there was little concrete knowledge about the processes of chemical transformation. In the early 18th century much of the chemists' curiosity centred on the process of burning, and the nature of air. But the progress on these questions was seriously hindered by the belief in phlogiston theory.

Since the burning of wood involved very complicated chemical processes, with many different substances taking part, little progress was made so long as people tried to understand the process of burning by studying burning of wood. But when people started studying the burning of metals, it was found that the product of combustion weighed *more* that the metal that burned. By burning substances in a jar with its mouth in water, John Mayow (1649–1679) showed that the volume of air decreases when something is burnt. He also showed that the volume decreases by the same amount when a mouse is left to

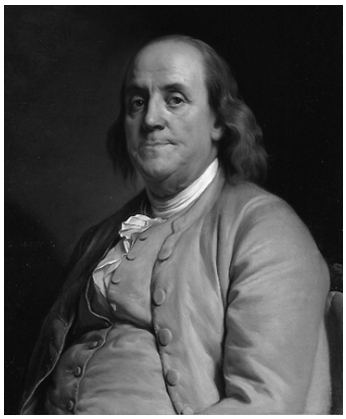

Figure 5: Benjamin Franklin (1705–1790).

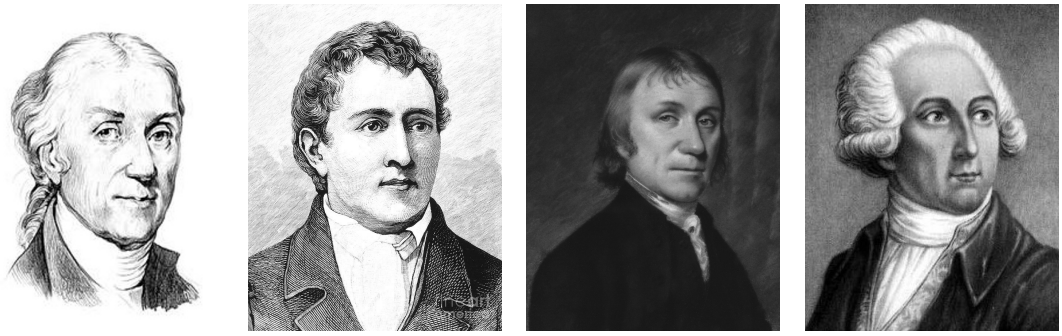

Figure 6: The players in the chemical revolution. L–R: Henry Cavendish (1731–1810), Carl Wilhelm Scheele (1742–1786), Joseph Priestley (1733–1804), and Antoine Lavoisier (1743–1794).

breathe in air confined in a jar until it dies. These were the knowledge available when people like Scheele, Priestley, Cavendish and Lavoisier confronted the problem.

Scheele was a very competent Swedish chemist who discovered chemical elements such as barium (1774), manganese (1774), molybdenum (1778), and tungsten (1781), as well as several chemical compounds, including citric acid, lactic acid, glycerol, hydrogen cyanide, hydrogen fluoride, and hydrogen sulfide. It was probably he who first isolated oxygen. But he failed to understand its role in burning, because of his belief in the phlogiston theory. Henry Cavendish discovered hydrogen, and showed that it burns completely producing only water. But he thought he had succeeded in isolating phlogiston. Joseph Priestley made an arrangement of heating substances by focusing sunlight using a large lens, and used it on a substance called "red powder of mercury" (basically mercuric oxide). He found that a colourless gas emerged from the powder. He experimented with the gas and found that it aids burning. Yet, because of his adherence to the phlogiston theory he failed to identify it as oxygen that forms part of air.

Lavoisier, the French chemist, was free of such preconceived notions. He replicated these experiments, and managed to see what others failed to see: that this gas, oxygen, formed part of air. It is this gas that combines with substances in the process of burning, thus increasing the weight of the product. It is this gas that aids breathing — a process in which it gets converted into carbon dioxide. Because of this insight he is credited with the discovery of oxygen, even though others preceded him in isolating the gas. It was he who categorized substances as oxides, salts, acids, alkalis, etc., and founded modern chemistry as we know it today.

After this decisive break with the past, chemistry advanced unhindered, and within a century all the naturally occurring chemical elements and most common compounds were discovered.

The rise of empiricism

It is to be noticed that in all these advancements the essential inputs came from experiment. Incorrect fanciful ideas were slowly being dispelled by conducting careful experiments. Mankind was taking successful steps in understanding Nature, by following the demands of objectivity.

In this background, in the realm of phi-

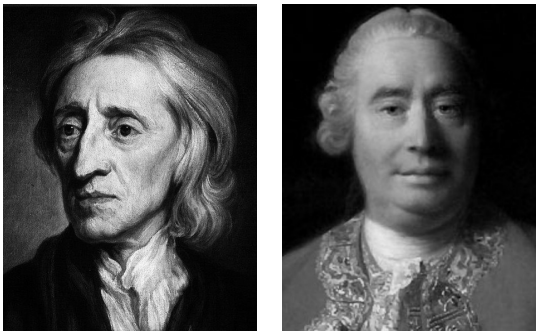

Figure 7: The early empiricists: John Locke (1632–1704), and David Hume (1711–1776)

losophy the idea of empiricism was developed by Locke, Hume, and Mill, which demanded that one should rely only on experience as the source of ideas and knowledge. John Locke, in his book "An Essay Concerning Human Understanding" (1689) proposed a very influential view that genuine information about the world must be acquired by *a posteriori* means, because nothing can be thought without first being sensed. According to him, the human mind is a "white paper," on which the experiences derived from sense impressions as a person's life proceeds are written.

The idea however did not go unopposed. The Irish Anglican bishop, George Berkeley (1685–1753), realized that Locke's view was in essence materialistic in nature, and hence challenged the Church propagated beliefs. In his "Treatise Concerning the Principles of Human Knowledge" (1710) he proposed the view that things only exist either as a result of their being perceived, or by virtue of the fact that they are an entity doing the perceiving. Berkeley maintained that any order humans may see in nature is the language or handwriting of God. Berkeley's philosophy later came to be called subjective idealism. This philosophy did not attract much attention during his lifetime, as in the post-Newton era mechanical materialistic views held sway. But later this view was adopted as the main philosophical plank for those who wanted to oppose materialism. Even today we see Berkeley's shadow in many current writings.

The Scottish philosopher David Hume responded to Berkeley's criticisms of Locke, and moved empiricism to a new level of scepticism. He urged people to have a questioning attitude towards ideas, opinions, and beliefs that are stated as facts and are taken for granted. Hume argued in keeping with the empiricist view that all knowledge derives from sense experience; that even the most basic ideas about the natural world cannot be conclusively established by reason. Rather, he maintained that these are more a result of accumulated habits, developed in response to accumulated sense experiences.

Thus we see that empiricism emphasized evidence, especially as discovered in experiments (and in case of astronomy, in observations). It demanded that all hypotheses and theories must be tested against observations of the natural world rather than resting solely on *a priori* reasoning, intuition, or revelation. The nineteenth century philosopher John Stuart Mill (1806–1873) later argued that all human knowledge, in-

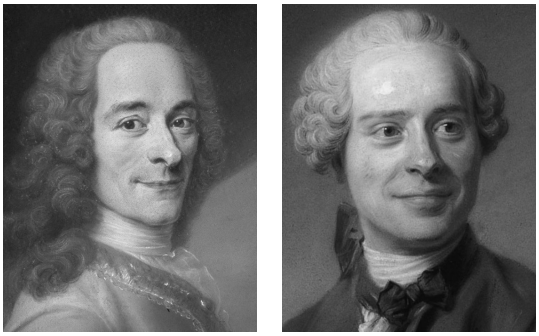

Figure 8: The encyclopedists: Denis Diderot (1713–1784), and Jean-Baptiste le Rond d'Alembert (1717–1783)

cluding even mathematics and logic, is derived by generalization from sensory experience.

The development of science in the eighteenth century was occurring in the intellectual atmosphere of empiricism. It helped dispel the unfounded beliefs that blocked the advancement of science. But, as we shall see later, the further development of this philosophical trend gave birth to positivism in the nineteenth century, which also misled scientific investigation for quite a long time.

Wave of Enlightenment Reaches France

These developments occurred mainly in Britain. In France the intellectual atmosphere was dominated for a longer time by the dry scholasticism of the seminaries, where people argued endlessly about the meaning of each passage of the Bible, and Aristotle's writings. But around the middle of the eighteenth century enlightenment reached France like a wave. Discussion groups or "salons" sprang up that discussed topics ranging from science to ethics, morality, politics, and aesthetics on the basis of the spirit of enlightenment. Voltaire (1694–1778) was instrumental in disseminating Newton's philosophy in France. Finally a group of prominent intellectuals led by Diderot and d'Alembert decided to compile the entire knowledge accumulated till that time in the form of a massive "Encyclopedie".

It became a rallying point of free-minded intellectuals and scientists who contributed to it over a long period from 1751 to 1772. It was published in 35 volumes and became immensely influential in spreading the message of enlightenment in the European countries as well as in America.

Most historians think that the Encyclopedia played a major role in creating the intel-

lectual backdrop of the American revolution (1781) and the French revolution (1789) as the political ideals of the enlightenment, as embodied in the Encyclopedia, were incorporated in the American Declaration of Independence, the United States Bill of Rights, the French Declaration of the Rights of Man and of the Citizen, etc.

The mood of the time can be aptly seen in the life of a front-ranking French scientist of that time, Pierre Simon Laplace (1749–1827). He was a mathematical physicist after whom the famous Laplace transform (one of the basic mathematical tools in an engineer's kitty today) and the Laplacian operator (the basic mathematical tool for understanding electromagnetism and waves) are named. His prime contributions were in the area of celestial mechanics, especially in proposing the first scientific theory of the origin of the solar system. For some time he was a minister in the cabinet of Napoleon after the French revolution. After his book on celestial mechanics "Exposition du systeme du monde" was published, Laplace went to Napoleon to present a copy of his work. Someone had told Napoleon that the book contained no mention of God. Napoleon received the book with the remark, "Mr. Laplace, they tell me you have written this large book on the system of the universe, and have never even mentioned its Creator." Laplace answered bluntly: "I had no need of that hypothesis."

One of the major conceptual developments in the 18th century and the early 19th century was the development of the concepts of causality and determinism, which set the agenda for science for years to come. We shall delve upon these issues in the next instalment. □

The earlier instalments of this article are available in the "Archives" link of www.breakthrough-india.org