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# Obituary

## Homage to Professor Stephen Hawking<sup>1</sup>

Breakthrough Science Society deeply mourns the demise of the renowned British physicist Professor Stephen Hawking. His dedication overcoming crippling physical disability, and subsequent achievements in science made him a household name and inspiration across the globe.

Renowned for his theories on black holes and origin of the universe, he was known for encouraging other researchers. By creating an example with his own life, he has taught us how to lead a meaningful life despite all odds. For five decades he was staring at the eyes of death, and yet carried on with the productive life of a scientist: going to the university every day, doing research, guiding students, attending conferences, delivering talks, writing popular science books! At no point of time did he express grief for his disability. Rather he was always a man with positive attitude, who dared to do what everybody thought would be impossible for him. The words “Work gives you meaning and purpose, and life is empty without it” truly represent his attitude to life. Despite his physical ailments, he was known for his ready wit and sense of humour.

Prof. Hawking was not an ivory tower scientist, and was alive to social problems. Whenever an injustice came to light, he was



Prof. Stephen W Hawking (8 January 1942 – 14 March 2018)

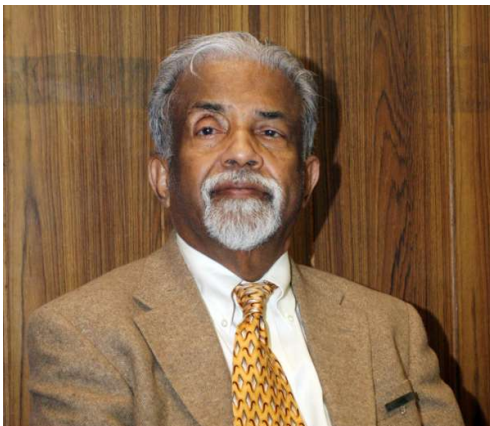
often the first to protest. He dealt with the state of affairs of human society, on issues that very few scientists of his stature bother to think about. He steadfastly defended scientific temper and many times issued public statements refuting the prevailing belief that a supernatural force is responsible for the creation and evolution of the universe. He stands as a giant in the field of modern science.

While his demise is an irreparable loss, the work and legacy of Stephen Hawking, a brilliant scientist and an extraordinary man, will live on after him. His courage and persistence should serve as a model and inspiration for all scientists, especially the young, and those who wish to push forward the frontiers of science. The legacy left by him encourages us to endeavor to change this world for a better future.

We bow our head in reverence to the memory of Professor Stephen Hawking.

<sup>1</sup>Resolution by Breakthrough Science Society West Bengal Chapter in the memorial meeting held at Rajabazar Science College, Meghnad Saha Auditorium, Kolkata on 29th March 2018.

## Obituary



Prof. E C G Sudarshan (16 September 1931 – 13 May 2018)

### Obituary to Prof E C G Sudarshan

Breakthrough Science Society mourns the passing away of Professor E C G Sudarshan on 14 May 2018, whose seminal contributions to theoretical Physics have enriched our understanding about the material world. Sudarshan's illustrious career in physics began in CMS College, Kottayam, followed by Madras Christian College (MCC) Chennai and Tata Institute of Fundamental Research (TIFR) Mumbai. It was the great teachers in the MCC who laid the strong foundation of Physics in already well trained Sudarshan. During his days in TIFR he befriended the legendary P A M Dirac whose lecture notes he was assigned to transcribe. Another visitor to TIFR, the renowned theoretical nuclear physicist R E Marshak, was so impressed by Sudarshan that he invited Sudarshan to join him in Rochester as a PhD student.

It was Professor Sudarshan, along with Professor R J Glauber, who developed what is known as the "coherent state representation" for the quantum theory of light. He is also well-known for VA theory, which later helped scientists to understand electro-weak forces in nature. Because of these

seminal contributions he was nominated twice for Nobel Prize. Along with these, Professor Sudarshan also made seminal contributions in foundations of quantum mechanics. Working on the implications of special theory of relativity, he found a way for particles to travel faster than light. These particles were named tachyons. Though it remains a mathematical exercise with no experimental confirmation, it attests to professor Sudarshan's considerable theoretical prowess and scientific audacity.

Professor Sudarshan founded the Centre for Theoretical Studies (now the Centre for High Energy Physics) at the Indian Institute of Science and was the director of the Institute of Mathematical Sciences in Chennai. With his demise the world has lost a great creative mind and an outstanding theoretical physicist.

### Condolence Note on G S Padmakumar, Vice-President, All India Committee, BSS

On April 28, when we received the news that G S Padmakumar, the President of the Kerala Chapter of Breakthrough Science Society, and Vice-President of the All India Committee of BSS, had passed away that morning due to a cardiac arrest, we were all taken aback. That we have lost him is still to sink in.

We all know of his participation in various issues concerning students, education and people's problems right from his student days. It was the same enthusiasm and dedication that he brought to developing the science movement in Kerala. He initiated and led several programmes on various issues of science, right from popularising science among the young, to organising discussions on current topics, involving both scientists and the common man, with a view to spread the scientific method and temper among the people.

## Obituary



G S Padmakumar

He believed that the necessary social change cannot be achieved without creating a science movement. With that conviction, he played an important part in the efforts of the Breakthrough Science Society, in countering the current of unscientific and pseudo-science ideas, especially in the name of ancient Indian glory, being unleashed, often with official patronage, especially in recent times.

As part of the global science movement, his role in the many programmes held in Kerala in connection with the India March for Science last year and the March for Science this year, which was held on April 14, just two weeks before his sudden and untimely demise, was notable.

Padmakumar was a very good communicator. He could explain ideas, however complicated, in a lucid manner to even a layman. He played an important role in bringing out popular science books in Malayalam like 'Einstein's Theory of Relativity' and 'Darwin and the Theory of Evolution'. He also played pivotal role in bring out a documentary on the life, work, and human values of Madame Curie, and a bi-lingual pictorial exhibition on the life and work of Albert Einstein, both of which received critical acclaim of the scientific community.

Deeply into literature, he was a voracious reader. He was a good writer and translator and he also put his pen to poetry, well appreciated by those familiar with his writings.

His demise is a great loss not only BSS but for all those who knew him through his science and social activities. We lost a strong organizer of the science movement and a good human being of gentle nature but strong conviction. All of us who had the privilege of knowing and interacting with him will always remember his warmth, affection, ready helpfulness and, of course, his sense of humour.

The All India Committee of the BSS and all BSS activists and members pay homage to his memory and offer our heartfelt condolences to all those whose lives he was a part of.

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## On the India based Neutrino Observatory (INO)

Neutrino is a subatomic particle that has no electrical charge and has a very tiny mass. Neutrinos are one of the most abundant particles in the Universe. Billions of neutrinos from the sun pass through the earth every second. Wolfgang Pauli first postulated the existence of the neutrino in 1930 to explain the conservation of energy and angular momentum in beta-decay. The first detection of neutrinos was reported by Clyde Cowan and Frederick Reines in 1956.

According to standard model of particle physics, they are massless. However recent experiments indicate that these charge-neutral particles have finite but small mass which is yet unknown. There are three types of neutrinos: the electron-neutrino, the muon-neutrino and the tau-neutrino, with slightly different masses. Determination of neutrino mass is one of the open problems in physics today. The study of neutrino is important for understanding the basic structure of matter and the evolution of the Universe. Since neutrinos interact with matter very weakly, the detection and characterisation of neutrinos is a big challenge. An underground laboratory that can shield all other radiations is a primary requirement for the detection of neutrinos. Several laboratories have been built in the world and a few are under construction.

Historically, Indian initiative for neutrino research goes back several decades. The cosmic ray neutrinos were first detected in India in the deep mines of Kolar Gold Fields (KGF) in 1965. But the mine was closed in 2001. The possibility of a neutrino observatory in a cavern under a suitable hill in

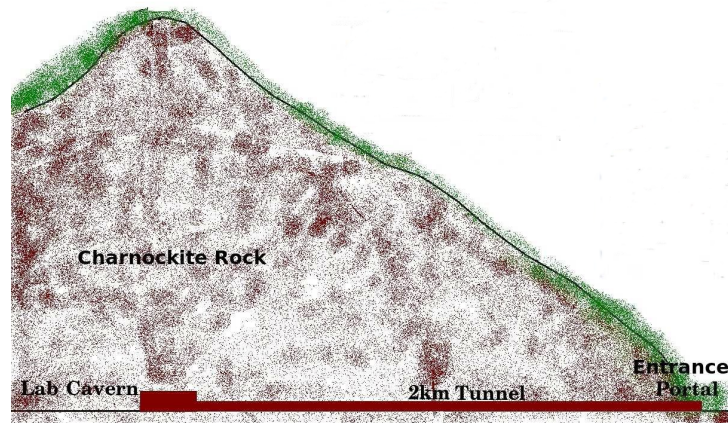
India was discussed and finally a proposal was submitted jointly by 25 institutions in 2006 to the Govt. of India. This is considered to be a first of its kind largest open scientific collaboration in India.

The project proponents identified a couple of sites for the project. One site was near the Rammam hydel project located in the Eastern Himalayas in the district of Darjeeling. Among many reasons, this site was rejected as it falls in seismic zone 4. Another possible site was Suruliya in Tamilnadu, but due to lack of data on the characteristics of the rock, it was given up. The third one was under the Nilgiri hills at Singara in Tamilnadu. Considered by the physicists as the best available site for INO, they were eagerly awaiting for the clearance from Ministry of Environment & Forests (MoEF). After a long wait they lost this choice as the EIA report pointed out the impact on wildlife in the Nilgiri Biosphere Reserve. The next site chosen was the Bodi West hills in Theni district of Tamilnadu, close to the border of Kerala. The project got final nod from the Centre in March this year. The project costing nearly 1500 crores is funded jointly by the Department of Atomic Energy and the Department of Science and Technology.

As per the INO report, the project includes:

1. Construction of an underground laboratory. The underground laboratory consists of a large cavern of size  $132\text{ m} \times 26\text{ m} \times 20\text{ m}$  that will be accessed by a 2 km long and 7.5 m wide tunnel. (See figure)

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Schematic view of the hill, the proposed laboratory, and the tunnel

2. Construction of an Iron Calorimeter (ICAL) detector for studying neutrinos. It consists of 50,000 tons of magnetized iron plates arranged in stacks with gaps in between where Resistive Plate Chambers (RPCs) would be inserted as active detectors.
3. Setting up of National Centre for High Energy Physics at Madurai, for the operation and maintenance of the underground laboratory.

Some technical objections have been raised against the project by a few organisations and environmental groups. Some genuine apprehensions are also there in a section of the people.

In the case of the neutrino project, since people may not be having much idea about particle physics and related aspects, some undue fear and concern may also be there. Tamilnadu has been witnessing a series of protests against various issues like the Neduvasal Hydrocarbon Extraction in Discovered Small Fields (DSF), the gas leaks into several acres of agricultural land from abandoned ONGC wells in Kathiraman-galam, the Coal Bed Methane Project in Kaveri delta. In this background, it is quite

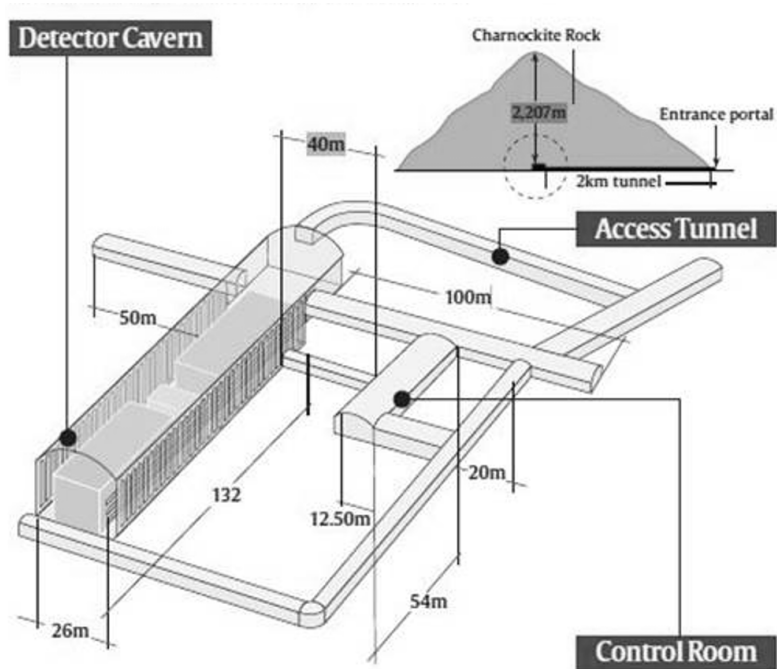
natural that people are apprehensive about the neutrino project too.

Initially there was some fear among the general public that neutrino radiation like other nuclear radiations may be harmful to life. But through media and news articles when people came to know that neutrino is not harmful to life like other radiations this fear slowly died down.

Presently one of the most important concerns is that the blasting of rocks for the construction of the tunnel and cavern may affect the ecology of the nearby Western Ghats area and it may also cause damage to the dams like Mullai Periyar and other nearby dams. It may be noted that the dams are more than 20km from the INO site. The nearest village is about 2km from the site.

There have been many exchanges of arguments and rejoinders between opponents and proponents mainly centring around the geo-tectonic nature of the site and the effect of tunnelling on the rock. The essence of the views of those opposing the project from the standpoint of the supposedly fragile nature of the rock, effect of tunnelling on ground water table and safety of dams in

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The layout of the proposed laboratory. (Figure - Courtesy: The New Indian Express, 3rd April, 2018)

the vicinity can be found in the article by V T Padmanabhan and Joseph Makkolil (Ref 1). These arguments have been countered by V Balachandran (Ref 2) as well as by B S Acharya (Ref 3). Geological experts opine that the rocks in the Bodi West hills are of hard crystalline type (Charnockite) and are very stable. The problems associated with tunnelling are well documented. In the Western Ghats region around 90 tunnels have been built for the Konkan Rail, the longest tunnel being 6.5km long.

The geotechnical study conducted by the team from the Geological Survey of India at the INO site does not indicate any adverse problem (Ref 4). The INO documents say that the tunnelling will be carried out by controlled blasting. In such blasting, the impact due to vibrations are negligible beyond 1 km.

The Mathiketana Chola National Park that

is very rich in biodiversity is about 5km from the site. There are concerns by environmentalists that there may be disturbances, particularly to sensitive animals in the park. A detailed study of the impact on the ecology has been made by the Salim Ali Centre for Ornithology and Natural history (Ref 5).

Another important concern is that the project may consume a lot of water. People in the area are facing severe shortage of water for farming and drinking purposes. If the project uses up the local water resources it will be a serious problem.

The INO is not similar to a chemical processing plant where water is an important input. The INO has clarified that the water requirement after the commissioning of the lab is around 350,000 litres per day. The figure may look large, but it is actually equivalent to the water consumed

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by the population of a single street in a city suburb, about 35 lorry-tankers of water. This water is going to be sourced from the Mullai Periyar dam directly through pipes. Of the available 25 TMC (Thousand million cubic feet) of water in Mullaiperiyar dam in a year, the requirement for INO is about 0.1 TMC per year as per the INO reports. During the construction stage the water consumption will be much less. If this is the case, there will not be any adverse impact on the availability of water in the area.

There are also some other concerns like people may lose the cattle grazing land. The local people use the lower portions of the hill and the nearby areas for the pastoral needs of the cattle. Their concern is that once the project comes up, there may be curbs on cattle grazing. The laboratory is inside the cavern and government land is available for the housing needs of the limited number of staff managing the observatory. The INO does not need any land acquisition and there will not be any obstruction to cattle grazing in the nearby areas.

Another concern is about the linkage of INO with weapons program. Due to the physical properties of neutrinos, there is no possibility of using these particles for any weapon related use. The INO's stated objective is to study the characteristic features of atmospheric neutrinos.

It is a long-standing demand of the scientific community that more money should be spent on basic science, in trying to obtain answers to our fundamental questions about the working of nature. After a long struggle, and dilly-dallying by the government, the proposed project has received a sanction of Rs. 1500 crores.

The INO is a basic science project. Indian physicists have been longing for more than a decade to realise this project. After going through the objections and rejoinders in

*Current Science* and other publications and examining the documents and reports of the INO, it is observed that the construction of the neutrino laboratory is not expected to cause any serious damage to the environment or to the people living in the nearby villages. The advancement of science is key to progress of society. It is important that a project of great scientific significance be pursued seriously. Government should take all measures to implement this science project and fulfill the long pending demands of the scientists.

The INO management, on the other hand, must comply with the regulatory and licensing requirements at every stage of construction and operation of the project. The INO authorities, the municipal agencies and the scientists associated with the project should engage in a healthy dialogue with the local people for allaying their concerns.

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5. Environmental Impact Assessment Report (INO website <http://www.ino.tifr.res.in>)

# AUTONOMOUS WEAPONS:

## AN OPEN LETTER FROM AI & ROBOTICS RESEARCHERS\*

Autonomous weapons select and engage targets without human intervention. They might include, for example, armed quadcopters that can search for and eliminate people meeting certain pre-defined criteria, but do not include cruise missiles or remotely piloted drones for which humans make all targeting decisions. Artificial Intelligence (AI) technology has reached a point where the deployment of such systems is – practically if not legally – feasible within years, not decades, and the stakes are high: autonomous weapons have been described as the third revolution in warfare, after gunpowder and nuclear arms.

Many arguments have been made for and against autonomous weapons, for example that replacing human soldiers by machines is good by reducing casualties for the owner but bad by thereby lowering the threshold for going to battle. The key question for humanity today is whether to start a global AI arms race or to prevent it from starting. If any major military power pushes ahead with AI weapon development, a global arms race is virtually inevitable, and the endpoint of this technological trajectory is obvious: autonomous weapons will become the Kalashnikovs of tomorrow. Unlike nuclear weapons, they require no costly or hard-to-obtain raw materials, so they will become ubiquitous and cheap

for all significant military powers to mass-produce. It will only be a matter of time until they appear on the black market and in the hands of terrorists, dictators wishing to better control their populace, warlords wishing to perpetrate ethnic cleansing, etc. Autonomous weapons are ideal for tasks such as assassinations, destabilizing nations, subduing populations and selectively killing a particular ethnic group. We therefore believe that a military AI arms race would not be beneficial for humanity. There are many ways in which AI can make battlefields safer for humans, especially civilians, without creating new tools for killing people.

Just as most chemists and biologists have no interest in building chemical or biological weapons, most AI researchers have no interest in building AI weapons – and do not want others to tarnish their field by doing so, potentially creating a major public backlash against AI that curtails its future societal benefits. Indeed, chemists and biologists have broadly supported international agreements that have successfully prohibited chemical and biological weapons, just as most physicists supported the treaties banning space-based nuclear weapons and blinding laser weapons.

In summary, we believe that AI has great potential to benefit humanity in many ways, and that the goal of the field should be to do so. Starting a military AI arms race is a bad idea, and should be prevented by a ban on offensive autonomous weapons beyond meaningful human control. □

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\*This open letter was announced at the opening of the International Joint Conference on Artificial Intelligence on July 28, 2015. To date, the open letter has been signed by 3978 AI/Robotics researchers and 22541 others. Appreciating its importance, the Editorial Board of *Breakthrough* decided to print it.

# What science entails, beyond practical science

S. G. Dani \*

The advent of science in the recent centuries has implications far beyond its practical applications, in our approach to understanding the world around and incorporating it into our way of life. This essay is aimed as a preliminary discussion on the theme.

## 1. How it all began

In the primitive world, as know-how began to be gathered the initial impulse was only to harness it towards meeting the basic needs. Gradually questions arose in the minds of people about the nature of the world around and in particular whether it has implications to human behaviour on a broader scale, at social as well as individual level. Since no coherent model for the happenings in nature could be thought of with the limited inputs at hand, a feeling evolved that nature is governed by something supernatural, or extraneous. The motivation then shifted to trying to identify how the supernatural intervened in the natural course, and to benefit from the understanding (both in terms of setting up goals—going to heaven, concern for consequences of actions during one's life to after death or rebirth, attaining *moksha* etc.—as well as appeasing the postulated agencies of the supernatural to gain functional benefits

in everyday life). Many principles emanating from this model (e.g. good behaviour so as not to incur the wrath of the agencies of the supernatural) served also as fruitful devices on account of their potential to bring stability of the societies. On the other hand, to be sure, doubters of such models have existed through the ages. A notable instance in the Indian context would be the Charvaka tradition from around 600 BCE<sup>1</sup>.

Incidentally though the Charvakas have

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<sup>1</sup>One oft quoted verse about them is

yavad jeevet sukham jeevet, rnam  
krtwa ghrtam pibet  
bhasmibhutasya dehasya punaragamanam  
kutah.

As long as you live, live happily; take loan to  
consume ghee  
Once the body is cremated how will it come  
back?

It is unclear whether this is an original formulation from the tradition or is a distorted version propagated by some detractors aiming to malign them, through what apparently appears an irresponsible advice on their part. Notwithstanding the status in this respect, it may be noted that even in that form it is far from being unreasonable, when seen in the right spirit. Contrary to the common (manufactured) perception the suggestion to take loan does not subsume you may readily default on them—in a stable society, in equilibrium, loans are possible only when there is some way of ensuring that they would be recovered, at least to a suitable measure. Thus the advice would normally incorporate also a commitment to repay the debt. It may also be pointed out that loan is advised for ghee, and not for alcohol for instance; consuming ghee was associated in the traditional society with keeping good health, which would in turn facilitate meeting one's responsibilities in life. — I may mention that these observations were made in a book by Sharad Bedekar, a prolific writer on related issues in Marathi, but do not have the precise reference.

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\*Prof. Dani teaches at the UM-DAE Centre for Excellence in Basic Sciences, Mumbai. Formerly he was a professor at the TIFR, Mumbai, and IIT Bombay. This is a revised text version of the talk given at the Curiosity Circle, Mumbai, on 13 January 2018, at the Homi Bhabha Centre for Science Education, Tata Institute of Fundamental Research, Mumbai.



been much maligned in the traditional milieu, their norms of behaviour were perhaps quite consistent with the modern day norms.

## **2. The scientific revolution**

The scientific revolution (during 15th to 17th centuries) brought in, apart from the massive technological boons, the profound realisation that there is really no limit to the amount of knowledge that humans can acquire about nature, into its deeper and deeper manifestations, at macro as well as micro levels. One major consequence of this to the thought process was to reduce the role of the supernatural agencies. The scientific method that evolved alongside the technological revolution did not need to accord any role to the supernatural. Being able to arrive at explanations of phenomena in nature without recourse to the supernatural was seen to enhance one's ability to comprehend nature more effectively and to use the knowledge fruitfully in practice. As a consequence it also came to be incorporated as a crucial ethical principle in the practice of science — whatever the predilections of the individual practitioners in this respect, the scientific community expected that all reasoning and validation of knowledge be done through arguments internal to the system, not involving anything supernatural. For validation of knowledge material evidence was a fundamental criterion, and all inferences had to be based on sound, independently confirmed, principles of logic.

As it crystallized, the scientific method of acquisition of knowledge may be described as a system going through the following steps. It begins with observations concerning things or phenomena that we encounter, which often develop into ideas or hypotheses about how nature functions, in whatever specific context is concerned. The

best hypotheses lead to predictions that can be tested in various ways. The most reliable tests of hypotheses come from carefully controlled experiments and logical analysis of empirical data. Depending on how well additional tests match the predictions, the original hypothesis may require refinement, alteration, expansion or outright rejection. If a particular hypothesis becomes very well supported, a general theory emerges.

This sets a model, or template (to use a more current word), for enquiry into the nature of things and validation of knowledge. A crucial point is that the method is of significance far beyond the everyday practice of science. Admittedly the method is not workable with equal facility in all contexts. There are a variety of difficulties, both at operational and theoretical levels. However there are some fundamental features that stand out and adopting them would stand us in good stead in our endeavour to acquire and validate knowledge concerning various aspects of life, that are not directly concerned practice of science itself.

## **3. Falsifiability**

Firstly, testability of a hypothesis is of paramount importance. A hypothesis which cannot be tested (e.g. the earth being supported on the hood of a giant *Sesha*, a serpent) has no place in the body of knowledge, even as a candidate. 'Falsifiability' is viewed as a primary criterion — if you cannot have a test which has a possibility of throwing up a negative outcome in case the statement is to be false, the statement is worthless and may be safely set aside.

A colleague once raised the issue as to how can you rule out the hypothesis that "if a cat crosses your path something bad will happen to you"? If many people find it to be the case, it would be unscientific to deny it! The hypothesis is in fact not falsifiable, since what is 'something bad' is

not well defined, and subject to one's point of view; even in the case of any particular individual could vary from time to time. On the other hand, if the statement were something like "if a cat crosses your path your blood pressure will go up in the next five minutes" is a testable hypothesis, but such a hypothesis is unlikely to ever come up. The more common response on the part of most 'reasoning' people would be to say "how would the cat know?" or in other words rely on our sense of causality, which is a part of our accumulated knowledge about nature. The causality test would fail in respect of both the questions as above. However, while causality provides a good test in practical contexts there is a limitation associated with the fact that the phenomenon may be valid and yet one may not have means of knowing the cause.

#### **4. Role of Questions**

Second major feature is the importance of coming up with **Questions**, as a means of enhancing knowledge. Since a question can in principle be answered in a variety of ways (say blah, blah, for instance) we need also to have the means of judging the merit of the answers. When a child I had read a wise-guy story in which the king asks the number of crows in the town. The wise guy cites a biggish random number (2573). The king wants it confirmed, but is soon informed that to confirm it one would first have to first ensure that no crow should enter or exit the town pending the process. Abreast of the difficulty of the task at hand the king closes the matter appreciating the smartness of the wise guy and rewarding him for it. Even as a child I remember feeling that there was something wrong with the answer; if many mutually exclusive answers can be given that are just as good as the other, what is the merit of any individual answer? Whatever the merits or

the amusement value of the story, as far as the issue of acquisition of knowledge is concerned it is a big no no.

The art of acquiring knowledge, whether in practical science or in other aspects of life, consists of asking good questions and being able to correctly evaluate the answers. A more typical and concrete situation involved in acquisition of knowledge is when together with the question you have a list of plausible answers, with a possibility and potential for expanding it, depending on the outcomes as they evolve in the process of testing the possible answers. This is not a very restrictive scenario, given that testing hypotheses is an important part of the process of augmentation of knowledge. If you cannot think of any possible answers to the question, there would be nothing to test, and no possible valid answers to the question. Of course, initial list need not be adhered to. You may happen to start with a question like what is the color of the bird that is flying across the garden, and while your initial list may consist of some primary colors, on closer inspection you may consider adding more of them or even add something like a shade between this and that.

The answers, and understanding on most issues, usually develop in steps. The subsequent answers may rule out the earlier answers; it is the brain that does the thinking and not the heart as was once thought! (The original idea would have been based on the response felt in the heart to various intense moments, and would have been 'confirmed' by certain tests, the idea had to be discarded following better understanding of biology, via other tests. The tests at any particular time can have limitations and the effects may be overcome by improved tests that better fit with a larger repertoire of observations. Questions like whether intake of vitamin C improves body resistance have seen a see-saw of

developments. On the other hand, in some instances later answers may subsume the earlier answers, as in the case of the relativistic mechanics incorporating Newtonian mechanics as a limiting case.

## **5. How and Why**

There is a general cliché that science concerns itself with questions of 'how' while metaphysical pursuits are equipped to answer 'why' questions. But this is very misleading. It is indeed true that science concerns 'how'? The issue about 'why' is rather complex. In some questions it is simply equivalent to 'how': 'why does the Earth go around the sun'? We use 'why' here rather than how, since the latter would normally correspond to description of the path (round, elliptical, oval etc.) whereas the issue involved is something else; but if you rephrase the question to "how does the trajectory of the Earth get determined?" and use our knowledge of Newtonian theory of gravitation we have the answer to "why the Earth goes around the sun". Many questions asking for 'scientific explanation' often get posed in this way, e.g., "why is the weather in Mumbai humid?" – which are equivalent to 'how' questions. On the other hand there are 'why' questions of other kind which are actually pointless: "why is man endowed with food sources on earth?". The anticipated answer typically is something like "by God's will", but it is meaningless as it is neither falsifiable nor testable. The question is pointless, since if there were no food sources, we would not be here to ask or answer the question. A question cannot be treated as meaningful or deserving of an answer simply by the test of following rules of grammar. Other 'why' questions like "why are metals hard and vegetables soft?" have a mixed flavour depending on the context in which you view them; from the point of view of condensed matter

physics it can be viewed as a 'how' question while in a lay context it is pointless — we simply accept them as their properties.

It may be clarified here that this is not a critique, or an argument against, asking 'why' questions. In practice we do need them and they are quite important. The point is that a 'why' question is good and meaningful basically when it can be converted into a 'how' question, perhaps an awkward one in some respects, and the 'why' is essentially a short or elegant form for the other formulation.

## **6. Pitfalls in the process**

Let me begin this section with a quotation from Ibn Al-Haytham (Alhzen in Latinized form), the Arab polymath who flourished in the 10th century in Basra, Iraq, renowned for his work on Optics. By some accounts he is the earliest practitioner of the scientific method.

The duty of the man who investigates the writings of scientists, if learning the truth is his goal, is to make himself an enemy of all that he reads, and ... attack it from every side. He should also suspect himself as he performs his critical examination of it, so that he may avoid falling into either prejudice or leniency.

Ibn Al-Haytham

In practice however it is a far cry to meet such an obligation in pursuit of truth. The practitioners are all too human and are prone to biases of various kinds and these affect both the choice of the questions and the findings: it may be worth categorising these as follows depending on their sources.

1. Predilections arising from personal motivations.
2. Preferences borne out of professional considerations.
3. Biases arising from parochial tendencies.

### **6.1 Personal aspects**

In the course of our early development we acquire a variety of prejudices, preferences, likes and dislikes. When a person engages himself/herself in scientific pursuits, the projects as well as reported findings may be affected by these.

By some accounts Copernicus was inclined to uphold the heliocentric theory out of faith in 'Sun God'. It seems also that some early works in bacteriology fudged the findings, purely out of personal convictions. These are instances where a bias led to breaking away from dogma. However, it could happen that personal biases lead to holding onto theories which may eventually be proved wrong, wasting a fair amount of work.

### **6.2 Professional issues**

There are a variety of professional pressures which lead to withholding or fudging one's findings. Gauss was aware of existence of non-euclidean geometries before they were discovered independently by Lobachevsky and Bolyai, but did not come out with it as he feared that it would seem rather crazy and harm his reputation. Apparently the charge of the electron determined by Millikan by the oil-drop experiment was actually higher, but several successive experimenters adopted values closer to Millikan's, discarding readings which were away from that, and the value stabilized only over a period of 20 years.

When a researcher takes up a project there is also a pressure to bring out something 'interesting' out of it. An anthropologist is more likely to highlight positive qualities of the subject tribe (unless negatively disposed from the outset, when the focus would be on negative qualities). Such a thing seems to have happened in early studies in Indology, which later had

a backlash where other authors began to aggressively fault the findings.

There are also issues about motivations coming from who is funding the research. Especially in medical sciences and environmental sciences, this is a major issue.

### **6.3 Parochial issues**

Though not so much in mainstream science, in studies in history, anthropology, sociology, etc. parochial considerations are seen to affect research. Many projects are coming up on exploring beneficial effects of *gomutra* (cow urine), etc. and in the current environment, with heavy revivalist overtones, one would wonder how much credibility can be granted to the findings, which are in any case unlikely to be dealt with through open and healthy scientific debates.

## **7. In place of a conclusion**

This discussion is meant to be a rudimentary exposition of what science entails, beyond direct aspects of scientific practice. There are inevitably many matters of detail involved; some of the issues about them are resolved at a technical or philosophical level, while others may be unresolved. Evidently there are also practical difficulties in following the method at an individual level, with the limited time and resources at one's disposal. One way of meeting this shortcoming would be to have a networking of people sharing the underlying ideas concerning scientific inquiry, and adhering to the basic principles with regard to validation of knowledge. Actively pursuing it as our *dharma* would no doubt bring further clarity. It would be of utmost importance however to sustain this valuable gift of science to the broader cause of charting our way through life, in the individual as well as social context. □

# Writing on the Wall of Time

Moncy V. John\*

The past two months witnessed two great losses to the scientific community, especially to the world of physics. Two distinguished physicists passed away, on March 14 and May 14, respectively. The first was Professor Stephen Hawking of the Cambridge University, whose life-struggle has no parallel in the history of science. In the past, we have celebrated many heroes who fought with their physical disabilities and attained a level of glory which even healthy people could not achieve. But Hawking's case is unique in this regard. The epic dimension of Hawking's struggle was unfolded during his lifetime and the future generations will marvel at his extraordinary feat of attaining the greatest heights of human knowledge from an unbelievable abyss of physical disability.

The other loss was that of the legendary physicist E.C.G. Sudarshan, who died at the age of 87. He made seminal contribution in expanding our knowledge on the most fundamental principles of the microworld, and is said to have been nominated for the Nobel prize many times only to get rejected every time. Yet, at least five of his works are considered to be of seminal importance and are acknowledged as such even by the Nobel laureates in the respective fields. Sudarshan hailed from a third-world country, and was only a first generation student of modern science in

his family. This adds further glory to his achievements.

Hawking was born in 1942 at Oxford, England. His parents were both educated at Oxford and were accomplished. He is remembered as a lively and adventurous boy during his period of study at the Oxford University. Hawking aspired to do research on cosmology at the Cambridge university. He barely managed to obtain a first class honours degree, which was a condition of acceptance for the PhD position. At that time, cosmology was in its early stage of development and there were two competing theories in the field. One of this is the big bang model that describes the origin of universe as a burst at some point at some moment of time, whereas the other is the steady state model which envisages a continuous creation of matter, keeping a steady appearance at all times. The famous cosmologist Fred Hoyle was at Cambridge at that time and was the leader of the steady state camp. Hoyle had made the path-breaking discovery on the formation of heavy elements in the universe, which we all are made up of, at the core of burning stars.

Though Hawking wanted to join Hoyle at Cambridge for research, the university assigned Prof. D.W. Sciama, who also was among the founders of modern cosmology, as his supervisor. Hawking is said to be initially a bit disappointed by this, for he thought of himself as not so well-trained in mathematics to work in general relativity. The distinguished Indian cosmologist

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Jayant Narlikar was also in Cambridge, doing his Ph.D. under Fred Hoyle during the same time. They were working on what was later called the 'Hoyle-Narlikar theory'. Hawking joined Sciama and soon attracted the attention of the research community at Cambridge for his intelligence and brashness. During one of his talks, he created some sensation by challenging the work of Hoyle and Narlikar, thereby identifying himself with the opposite camp. Later, when Hawking submitted his Ph.D. thesis on 'Properties of Expanding Universes', the first chapter was on 'The Hoyle-Narlikar Theory of gravitation'. Here also his attempt was to show that the expansion of the universe creates grave difficulties for the Hoyle-Narlikar theory of gravitation.

It was Hawking's work on gravitational and cosmological singularity, done in collaboration with Prof. Roger Penrose in 1969, that first made him well known as a cosmologist. Hawking and Penrose together formulated the so called 'singularity theorem', which demands that the universe must begin with a singularity to conform with the general theory of relativity and with one of Friedmann's cosmological models. For a long time, this theorem was posed as a binding constraint on every cosmological model. The steady state model of the universe does not have an initial singularity while the 'big bang model' has one. Physicists abhor singularity and hence this was considered as a drawback of the big bang model. It is interesting to note that at present, the big bang model has gradually metamorphosed into a non-Friedman model so that singularity theorem is no more a binding constraint on it. In other words, the Hawking-Penrose singularity theorem has lost most of its shine in cosmology today.

In the 1970's, Hawking turned his attention to black holes, the work for which

he is best known. Black holes are exotic celestial objects discovered to be existing at the galactic centres, first proposed on the basis of Einstein's general relativity. Hawking suggested certain laws of black hole dynamics by drawing an analogy between thermodynamics and the theory of black holes, based on general theory of relativity. Later, his interest turned to unifying the principles of quantum mechanics with the theory of black holes. This ultimately led him to discover that black holes can radiate energy, contrary to his own (classical) laws of black hole dynamics. These radiations are now known as 'Hawking radiation'. Though it is not yet detected in any observations, the prediction of this radiation is considered to be one of the most important scientific contributions of Hawking. However, passingly we note that he was not awarded a Nobel prize for any of his works, because they could not be confirmed by observations.

While a researcher aged 21 at Cambridge, he was diagnosed with the rare motor neurone disease called Amyotrophic Lateral Sclerosis. This was around the time when news came that he could not work with Fred Hoyle. Doctors were of the opinion that he would not survive for more than two years. But what the world saw was his incomparable feat of fighting all odds to survive and of fathoming the deepest celestial secrets. Not only did he pursue the most intricate theoretical cobwebs, but he also found time and energy to communicate these in clear and intelligible language to non-physicists. His book named 'A Brief History of Time' made him the best known science populariser in history, and it stayed at No. 1 in the best seller lists for years and broke all records. Though his motor neurone disease progressed slowly, finally overpowering him, it never affected his cheerfulness, nor did he allow it to



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prevent him from carrying out his scientific pursuits. In whatever he said or wrote, there was an element of humour. In physics literature, it is very difficult to find research papers where the author cracks jokes, except in those of Hawking!

The realm of physics in which Hawking worked was a meeting place for the largest and minutest possible sizes one can imagine, such as the entire universe and the Planck length, respectively. In such frontiers, human comprehension has its limits. Yet, Hawking has categorically stated many times that he is not a believer in God. In spite of his extreme physical disability, he never adopted an unscientific attitude or uttered a word that would help self-proclaimed godmen. However, like Einstein, he too has commented many times on 'God's designs', though mixed with some humour. Hawking's remarks on political issues, such as those on Trump's election in USA and the Brexit, also caught the headlines. Such comments showed his liberal left leaning, along with his characteristic intelligence, brashness and humour.

E.C.G. Sudarshan was born in 1931 to a Syrian Christian family near Kottayam, Kerala in 1931. His father E.I. Chandy was an accountant in the government treasury and mother Achamma Varghese taught in local schools. His name in the school records is Ennackal Chandy George (E.C. George), but he later added to it 'Sudarshan'. After the school education in and around Kottayam and intermediate education at C.M.S. college, Kottayam, he went to Madras Christian College, Chennai for the B.Sc. (Hons.) degree and then joined the Tata Institute of Fundamental Research as a research assistant. From there, he went to Rochester University for Ph.D. under Prof. Robert Marshak. For the rest of his life, he was mostly in USA. But never did he forget his alma maters nor his

homeland. He was always enthusiastic to take up research positions and responsibilities at research institutes in India. Prof. Sudarshan served at the Indian Institute of Science (IISc), Bangalore between 1973 and 1984 and was Director at Institute of Mathematical Sciences (IMSc), Chennai during 1984-1990. Another former director of IMSc, Prof. K. Srinivasa Rao has recently recalled how Sudarshan was instrumental, when he was the director at IMSc, in helping Janaki Ammal, wife of the legendary Indian mathematician Srinivasa Ramanujan. While delivering his memorial speech at CMS college, Prof. Rao has remembered him as a warm person who was always ready to extend his help and to use his influence for the needy. "One day a call came from the U.S. It was Dr. Sudarshan who asked me to find Janaki Ammal, widow of Srinivasa Ramanujan, who was living in obscurity." The Hindu newspaper has reported Prof. Rao as saying that nobody knew where she was living and it was with great difficulty that he found her. With the help of a private company, they could donate a lump sum and arrange a monthly pension to her.

When Sudarshan was still a student under Marshak, the field of theoretical physics was in a state of turmoil. The phenomenon of beta decay, the process by which electrons are emitted from radioactive nuclei, had competing theories for an explanation. There were also some experiments which give contradictory results in this connection. All the famous theoretical physicists of that time were working hard to find a solution. In fact, it was the solution of this problem which finally culminated in the theory of weak interactions. Further, the end-product in this pursuit was the standard model of particle physics, which was a major breakthrough in physics in the 20th century after the discovery of

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the theory of relativity and the quantum theory. The key point in resolving the theory of weak interaction was that the nature of weak interaction is V-A (Vector minus Axial vector). In their book titled 'The Second Creation: Makers of the Revolution in 20th Century', Robert P. Crease and Charles C. Mann describe vividly the unfolding of events. It was the 26 year old graduate student E.C.G. Sudarshan, after reviewing all available experimental data, who first came to the conclusion that the weak interaction must be V-A. His supervisor Marshak agreed and they together were convinced that some of the experiments must be wrong. But to Sudarshan's annoyance, Marshak hesitated to publish this result immediately. So they decided to wait till some more experiments are completed. In the meantime, they described this result in an informal meeting with Murray Gell-Mann, who in turn discussed it with Richard Feynmann. The duo also were working on the same problem. Finally, the result was published by Gell-Mann and Feynman, months before Sudarshan and Marshak could do the same. J. Mehra, biographer of Feynman, has revealed that Feynman acknowledged Sudarshan's contribution in 1963 stating that the V-A theory was discovered by Sudarshan and Marshak and publicized by Gell-Mann and himself. But when Nobel prize was announced in 1969 for Murray Gell-Mann "for his contributions and discoveries concerning the classification of elementary particles and their interactions", there was no mention of Sudarshan and Marshak!

A similar situation occurred when Roy Glauber of Harvard University published his paper on 'Quantum Optics', a few weeks earlier than Sudarshan's independent work on the so called  $p$ -representation. Prof. Rajaram Nityananda of the Azim Premji University, who has worked earlier with Ra-

man Research Institute and Tata Institute of Fundamental Research, remarks that while Glauber's was a first provisional step, clearly Sudarshan's paper laid out the full picture pretty much in its final form. He also mentions that Sudarshan's frustration at the award of the Nobel Prize to Glauber is perhaps understandable. Sudarshan's other contributions, namely tachyons, symmetries and quantum theories, spin and statistics, quantum Zeno effect, and evolution of general quantum states, are all outstanding and many believe that for these works also he deserves the highest accolades. His postulation of tachyons has carried much media attention, but Sudarshan himself has made it clear that this is just a proposal and need not be taken as any kind of discovery worthy of Nobel prize or the like.

When asked, Sudarshan often said that he believed in God. This was, of course, according to his own definition of God. He left Christianity later in his life, and had become a 'Vedantin Hindu'. The Hindu philosophy, in general, allows plurality in such concepts. Though Sudarshan was curious about mystic and supernatural experiences, he was more interested in understanding the philosophy of Hinduism embedded in the Vedas and Upanishads. At times, he even attempted to connect the principles of physics with the Vedantic philosophy. However, not many among his students or colleagues could appreciate these traits, since practising physicists generally consider such connections as off the mark! Neither it seems to have impressed many Hindutva philosophers in India.

Now, having with us the life sketch of these two great physicists, we make a comparison of their contributions and their research career. This will provide us with some valuable insights into the working of science in general. The enterprise called

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modern science has a history of a few centuries; but it has altered the course of human history beyond recognition. Science is still the greatest mass movement with which one can find freedom from oppression. It has arrived at this position by pushing back organised religions that often offered this freedom, but eventually stood with oppressors. But it now seems that the latter is attempting a comeback, making use of some functional weaknesses in science. The reactionary philosophies masquerading themselves in various forms such as postmodernism, try to portray science as just another ideology. Denial of the existence of an objective reality out there is one of major placards held by them. It is time we identify these threats and make a thorough search of any weak spots in science.

What characterised science in its formative years was the use of reason. The successes in understanding the basic laws of the physical world led to technology and the industrial revolution, to go hand in hand with the Renaissance which spread first in Europe and later all over the world. Every physical law was formulated with the help of reason and mathematical logic, but they must agree with experimental results. Without the support of experimental evidence, a physical theory remains a hypothesis or model and may be discarded later if experimental data go against it.

When the Nobel prize was instituted in 1901, it was made mandatory that the prize be given only for a discovery with strong experimental evidence. In physics, for this reason, many illustrious scientists were denied Nobel prize. In this light, it does not appear too strange that even Albert Einstein was awarded the prize for his theoretical explanation of the photoelectric effect, which is an experimentally verified phenomenon, and not for the theory of rel-

ativity for which experimental confirmation came after a long time. A general impression among physicists is that Einstein deserved to get a Nobel prize for relativity when observational evidence came, though belatedly. But it did not happen. The implementation of the above guideline has flawed at times, as in this case, but one cannot question the rationale behind the Nobel Committee's policy of awarding the prize only for a discovery with strong experimental evidence.

It is in this context that we compare the denial of Nobel prize to both Hawking and Sudarshan. In the case of Hawking, the denial can be seen to be according to the usual practice of the Nobel Committee. Hawking's theoretical works are hypotheses or models without experimental support, though they are strongly supported by mathematical logic. Even Hawking himself has not complained, probably because he agreed with the decision. Among his theories, the Hawking radiation has the highest prospect of being experimentally proved some day. In future, if this radiation is detected in some astronomical observation, we can describe that theory as an experimentally verified theory.

When compared to Hawking, there is a clear denial of justice to Sudarshan. Most results of Sudarshan (except that of tachyons) are validated in numerous experiments. We have seen that two of them, namely the V-A theory and the  $p$ -representation in quantum optics have been recognised by the Nobel committee as worthy of the prize. Sudarshan's complaint is only that the prize is given to someone else! The Nobel committee has not yet made known the reason behind these denials. The rule is that the minutes of the committee decision can be released only after 50 years.

*(Continued to page 34)*

# Astrology Opposes Science and Rationalism

Subrata Gouri\*

Nowadays belief in astrology is almost all-pervasive. We see highly educated, as well as less educated people wearing, not one but several rings with colorful gems. Practicing astrologers from footpath foretellers to high profile astrologers have hardly any scarcity of customers. Since astrology has had deep rooted impact on people over the ages, we need to analyse this matter critically.

The subject, of late, has become very significant, since some fundamentalist groups getting overt and covert patronage from even persons in power, have started concerted attacks on history and practices of science. It is very important to achieve real scientific and secular outlook in order to combat trends like the introduction of subjects like Vedic astrology in academic syllabus. It was initiated by previous NDA government and then onwards teaching of these subjects goes on uninterrupted.

## The prime belief of astrology

Astrology starts with the premise that some stars and planets have direct influence on human destiny. In our country, the idea of nine planets (Nava Graha) prevails. These nine planets namely, Sun, Moon, Mercury, Venus, Mars, Jupiter, Saturn, Rahu and Ketu influence every activity of human world. The question why they are called planets will be discussed later.

Astrology believes that the future of a new

born baby is determined by the position of stars in the sky, at the time of birth. The position of the moon decides the zodiac sign. There are huge differences among the astrologers of different countries on what determines the proper birth time of a newborn baby. Some of them believe that it is the time of delivery; some others opine that it is the time of cutting the umbilical cord. In ancient Greece and Babylon, horoscope was drawn up during the period of pregnancy.

Astrology tries to explain the influence of the stars on different persons. People rush to astrologers believing that they have some outstanding power to foretell one's destiny and can reduce, enhance or control the influence of stars.

## A few pertinent questions

Before discussing the influence of celestial bodies on human life, we would like to discuss on some pertinent questions as to why there is no mention of Uranus, Neptune and Pluto in Indian astrology. Why there is no mention of the Earth where we live, breathe, and acquire food for our lives? The fact that sun and the moon are not planets is known to even children nowadays. Actually, in ancient time, they had been treated as planets as per the geocentric concept. People believed what they could see with naked eyes. They believed that the sun and the moon and other celestial bodies are planets revolving round the earth. This concept was proved wrong by Copernicus a few centuries later.

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Then why do astrologers still nourish that old concept even today?

Again, astrology mentions two mythical planets i.e. Rahu and Ketu which are actually only two points of the space actually. Besides, astrology does not mention the influences of Uranus and Neptune and other moons of Venus, Jupiter, and Saturn, except moon of the earth though they are larger than our moon. Astrology mentions only 108 stars out of 5000-6000 visible to naked eyes.

### **How much is man influenced by stars and planets?**

Astrology considers those nine planets as gods or demons. They think that one can either be affluent bestowed with the divine grace or be in adverse situation by the influence of demons. It depends on the location of planets. So, astrologers prescribe for gems or precious stones for mitigating the evil effects.

Modern science has proved that gods or demons are merely the product of man's imagination. So, astrologers need some 'scientific' explanations to describe how stars or planets, millions of kilometres away from earth, exert powerful force influencing the life of a new born baby. Gravitational force exerted on earth by celestial bodies is a weak force and cannot act unequally on different persons. If one claims of any other force, one will have to explain the force scientifically as well as the method to quantify that force. If stars and planets can determine the future of a baby during its birth, the future of all the babies born at the same time should be same. But, in reality, they are different. Thousands of people died in super cyclone of Orissa in 1999, horrible flood in West Bengal in 2000, earthquakes in Gujarat in and Uttarkhand in 2000 and 2013 respectively, and heinous attack on Gaza by Israel in 2014 and so on.

Do all these events prove that during the birth time of those victims, the location of the stars and planets were same? Could astrologers foretell all these catastrophes?

Astrologers argue that if spring and neap tides occur due to the attraction of the sun and the moon, why not the events of human life? Primitive people believed that mental problems had close connection with the moon. This was because they did not believe in the existence of supernatural elements, which were not related to objects they see in their daily life. They sought explanation from the material world around. They did not understand the scientific reason behind every natural phenomenon. So the explanations were wrong to a large extent. Man would think so because they observed that the movement of moon and its incessant change of its shape. Today we are acquainted with its scientific reason. The word 'lunatic' comes from 'Luna' i.e. the moon. Modern science especially psychology can explain many factors that are responsible for human psychological problems and does not admit any lunatic factors. In 1969, American astronauts, Neil Armstrong and Edwin Aldrin, descended on the surface of the moon and stayed there for an hour. But, they are mentally very sound; never did they face any lunatic problems.

Another notion is that the moon affects human body also. During the new and full moons, one may feel that arthritic pain increases. Therefore, human body is affected by both the sun and the moon. If we accept this logic, it will only contradict the fundamental belief of astrology, for it is not related to birth-time and horoscope. And if arthritic pain increases in the new and full moon, why aren't other patients or normal people affected on those days?

### **Astrologer's predictions and truth**

The astrologers often claim that if astrology is fictitious, how do astrologers narrate the past incidents or predict the future so correctly? We cannot refute it outright. The general predictions based on common sense may become true in a very small number of cases. These sorts of incidents spread out among the friends and relatives quickly. People remember those incidents that come true and forget the rest.

Now, how do the forecasts of astrologers come true? In fact, we must keep in mind that there are two types of predictions i.e., speculation and scientific prediction. Speculation is based on assumptions and tries to find out similarities from some coincidences in a random manner. For example, the moment a crow flew above a palm tree, a fruit fell down. Should we deduce that the fruit has a cause effect relationship with the flying of the crow? No, because there is no causality in this incident. If it is seen that two incidents occur in same time in 5% cases, it may be said that they are co-incidental and there is no cause-effect relation between them. On the other hand, if the similarities are found in 95% cases, it is strongly suspected that they have cause-effect relationship. Scientific predictions rely on facts and their inter-relationships. For example, during monsoon we easily can easily predict that there will be rainfall, observing the formation of dense black clouds in the sky. So prediction comes out to be true in this case. We know the scientific reason behind this truth.

Astrology belongs to the first category. It has been estimated that in 25% -30% cases, the assumptions of astrologers come out true but in majority cases, they turn out wrong. The believers in astrology only remember the assumptions that come true.

Most of the astrologers, using their experience in dealing with persons in distress,

are capable of reading the psychology of the clients. Experienced and intelligent astrologers even extract information from their clients like a professional detective. Those weak and distressed people who have surrendered in the life struggle, answer to all the questions of astrologers and do not keep in mind that they have unknowingly provided much information to them. They are astonished when astrologers tell all the information back to them. In many cases popular astrologers engage paid informers for accumulating data of their customers. Even booking system and appointment are compulsory for the visitors in many cases. Sometimes the name and address and question of a customer have to be submitted before the visit.

Astrologers usually make prediction deliberately vague so that they never can be proved wrong in any incident. Suppose a student asks an astrologer whether he would pass in an upcoming examination. The astrologer may answer, "Your coming days are very auspicious as Jupiter is the ascendant now. But it is worrying that the relation between Jupiter and Mercury does not happen to be well. Therefore Mercury may work against the influence of Jupiter. So you are advised to wear rings with Pokhraz to subdue the influence of Mercury". If the student fails in the examination, the astrologer easily answers that Jupiter has been affected by Mercury. If the student passes the examination not wearing any ring, it will be explained that the Jupiter was in the ascendant. Thus, astrologers protect themselves so that people are not aware of their falsehood. A "heads I win, tails you lose" scenario.

But, things will be different if they try to predict something precisely. A story may be mentioned here. Bankim Chandra Chattapadhaya, the famous Bengali writer, believed in astrology. He married off his



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two daughters according to the advice of astrologers, who gave suggestions after examining their horoscopes meticulously. These two daughters were widowed just a few days after their marriage. Bankim Chandra in a letter to his son wrote "Do not rely on any astrological calculation any more. I have given this up after close examination". Recall the incident of astrologers examining the horoscope of the great scientist Satyandranath Bose and predicting his bleak academic future. And we know the truth

In the 1977 Parliament elections, Indira Gandhi was defeated and the Janata Party came into power. But, due to conflicts in the party, the stability of the government was in question. In July 1979, the then renowned astrologer and the secretary of Astrological magazine, B V Raman predicted that there was hardly any possibility of the fall of Janata government as Jupiter which was in the ascendant and would protect the government. After a few months, the government fell. Again, in November 1979, the same astrologer declared "In 1980, the position of stars and planets will be congenial to Janata Party. So, Janata Party must win. Indira Gandhi might be able to make her position a bit stronger, but will not be able to form the government". We know that Indira Gandhi formed the government with an overwhelming majority.

In 1984, another renowned professional astrologer named Sukracharya, the then president of Calcutta Astrological Society had predicted "Saturn and Mars have changed their positions. Saturn will not be in ominous side. As it is Mrs. Gandhi's ruling planet, there is no scope of her losing power. This position will sustain till November". We know she was killed by her own body guards on October 31 that year.

Now, recall two recent incidents. On

May 5, 2000, astrologers claimed that the earth would face tremendous disaster as the planets are being constellated almost near to the earth. But, scientists declared on the basis of their scientific study that our earth would be safe. In fact, the latter proved right. In the same way, since 2011, astrologers had been warning that in 2012 the earth would be destroyed. The scientists explained clearly that there was no possibility of destruction of the earth. Ultimately, astrologers proved wrong and we are still living on this planet.

### **Can metals and gemstones alter human destiny?**

Astrologers not only predict, but also claim to be able to change the future by providing various solutions. This is because of their profiteering motives. People burdened by the sufferings and setbacks of life, also look forward to wishfully change their fate. The claim actually contradicts itself. Astrology considers the fact that all incidents of our lives are pre-determined, that they have been destined at the moment of birth. So how is it possible that the predestined incidents can be changed by wearing amulets or gemstones or other good luck charms which can neutralize the negative influences of stars from our lives?

Let us now discuss the properties of these gemstones. We all know that there are 118 elements of which 91 are metals and the remaining 27 non-metals. So, it is surprising that astrology speaks of only 8 metals and is silent about the non-metals.

There are some 'scientific' explanations which the researchers of astrology try to provide. They say that since metals, like iron, are present in human body, they will work upon the human body in some form or the other. Many people tend to believe this logic. Even if it is possible for the metals to have an effect over the human

body but how can they have an effect like transforming the future?

Let us now consider the fact as to how much scientific it is to use the metals. If it is accepted that metals affect human body, then it is quite obvious that the metal which is abundant in nature should be considered first. But the astrologers do not even mention of calcium, the element which is found in abundance.

Now the question arises why only gemstones are used to eradicate negative effects or enhance future prospects. Gemstones are of varied colours and are beautiful too. Why not other stones? If we look back, we would find that from ancient days, man thought of colours to symbolize different features. Red symbolized death or danger, white symbolized peace, surrender and purity whereas black stood for sorrow or ominous things. This did not have any scientific basis but were folklore. The reason behind this leads us to the psychological development of man in the primitive age. They believed that if any object created a danger for him; the object had to be pacified using a colour identical to it. For example if planet Mars indicated danger, the use of red was prescribed. Similarly blue colour was used to pacify Saturn and white to pacify the moon.

Anthropologists term this custom 'sympathetic magic'. This was widely practiced when men lived in groups. Though these may have been erroneous, this approach was commendable as the primitive men sought to explain the cause-effect relationship from a materialistic viewpoint. Astrology negates the developments of the later stages of science and clings to those age old beliefs of the primitive stage of human civilization.

Let us now examine what these gemstones are. Do they have any special properties that may affect human life? Ge-

ologists opine that what we know as gemstones are actually ordinary ones. These are the oxidized form of the minerals like aluminum, sodium, calcium, silicon potassium etc. Minerals in their pure form are colourless. But the presence of other elements or matter within them contributes to the formation of these colours. These are generally oxygen amalgamated with iron or chromium compound. The adulterated minerals create some luminous coloured effects. These are used by astrologers to mystify and overwhelm the ordinary people.

### **Astrology: wrong judgment in recognition of time**

Past, present, and future; these words reflect the ideas of time. Astrology defines one's future which too involves time. What is it that astrology mainly propagates? The incidents in human life and affairs which occur every day are pre-determined as if everything has been programmed beforehand and inscribed on our foreheads or hands. Had all these been known a scientific invention would have been achieved very easily just predicting the future. Actually, astrology is based on the theory of pre-determination which is unscientific. Today, science has shown that all natural incidents are based on causality. Every incident has cause-effect relationship. Nothing is pre-determined. Rainfall needs an accumulation of clouds in a proper density. It can be understood by the theory of probability which is applied in micro-molecular world. The exact location of an electron cannot be defined. But, the probability of its location can be judged. This is applicable for all objects. But, we can say with conviction that nothing is pre-determined.

Modern science has proved that the conflict of an object with the outer world and its inner conflict determine its future. All phe-

nomena involve these conflicts. So, future can be presumed. One can explain possible future based on facts and governing laws.

### **Is there any objective ground for palmistry?**

Telling past, present and future has been proclaimed as an extraordinary unworldly power. Despite countless scientific inventions by innumerable scientists and their inexhaustible efforts for thousand years, what modern science has not achieved, astrologers claim to do easily with the help of palmistry. But if it were really possible, it would have lessened human labour. But is it really possible?

First, let us examine what is palmistry. We see two types of lines in an open palm. According to the astrologers, some of the thick lines are called heart line, some lifeline, some headlines etc. Other thinner lines indicate health, marriage and other events of life. And the bulging parts which are separated by those other tiny lines are called the areas of different planets. Is there any scientific ground for these beliefs? Astrologers have not given any adequate and satisfactory answers.

Modern science has shown how palm lines form during the embryonic stage in a fetus in women's womb. They are formed in various bone joints of palms and fingers in the hand's gripping posture. Science has also explained that in course of growth of a baby since infancy, many other small lines on palm either appear or remain permanently along with thick lines, or disappear due to daily contraction and expansion of muscles of the palm. Then, why do people believe in palmistry that claims to define past, present and future?

If palm lines can determine everything dealing with human life, how does a man live with arms cut-off or palms distorted? Nowadays, palm lines can be recreated or

destroyed by plastic surgery. Does it affect our fate? Sometimes the life line of a baby is seen indicating long life line but it died soon as after its birth. Will the astrologers be able to answer such questions?

### **Emergence of astrology**

We need to answer why and how astrology, which stands on a wrong footing, can still deceive people and entrap them by blind faith through the ages. To know this, we must go back to the origin and history of astrology.

From the very inception of human civilization, man tried to know and understand his surroundings. Man observed numerous cosmic bodies in the night sky and gathered knowledge gradually. This study of cosmic body was known as astrology then. During pre-historic times, the luminous stars were supposed to influence the life struggles of human beings. During the day, the only source of light was the sun and at night it was the moon. Again, man could calculate time, day-night, summer-winter, rain-drought, low-high tide of sea and river with the movement of the sun and the moon. Thus, they succeeded in making of almanac in olden days, calculating the month, seasons, years etc. In the same way, travelers while going through the dense forest, the deep valleys and river and lake, would take the help of larger planets like Jupiter and Saturn or a bright star like Venus for guiding them.

Man's thought and experience did not stand static. They observed the revolution of the sun and saw that the planets too had their own orbits. They saw the stars did not move but the sun and planets did. The path of the journey of the sun and the planets in the backdrop of the still stars came to be known as Zodiac. Keeping the Zodiac in the centre, the 18 degree wide path through which the planets

journey is called the Zodiacal strip. This circle was then divided into 12 parts and the stars in any one part were clubbed together, a shape imagined and was named in keeping with that shape. Thus the zodiacal signs are Leo, Capricorn, Pisces etc. Since the sun and moon changed their positions in the sky, they were considered planets. Obviously this was wrong but that astronomy was then at its natal stage, cannot be overlooked.

The planets and moving objects in the sky were compared to animals and their names were given accordingly in those days. They believed that like men, these stars and planets belonged to a family and had family relationships with one another. They believed that the Sun and Moon were benevolent to man since they saw their role in human life was always positive. They also thought of Jupiter and Venus as helpful planets. Mercury was not often seen so they considered it malevolent. Since Mars appeared red in colour, they considered it as a symbol of warfare and bloodshed and hence malevolent. They felt that the influence of these planets, good or bad, affected whole society, in this case the groups in which they lived in.

When agriculture developed, man began to produce more and some questions related to agriculture became important for them. For instance, questions like, which season was appropriate for cultivation of a particular crop or in which time of the year there would be heavy rainfall etc. needed answers. It was still then that they believed that the influence of the planets was same for all human beings. It was not considered to affect an individual only. Rather their influence on the whole group was considered. Some traces of this belief are still seen in our society. Those who believe in astrology believe that the noon time of Thursday bears negative effect on

all human beings or during solar and lunar eclipse food gets contaminated for all.

### **Class division: its effect on society**

The invention of agriculture brought about some important changes in the society. First of all, man got a permanent source of food. So a large number of people were involved in several newly introduced tasks in agriculture. Secondly, this also led to the inception of permanent property, which was the source of production.

Division in human society began to take place from that time. Among the fighting groups, the victorious one would kill the opponents who lost the battle or the defeated became the members of victorious groups. After the introduction of cultivation and domestication, a maiden thought struck the mind of the people of victorious groups that the use of the defeated ones in production process would be profitable instead of killing them. So, they were forced to work for production. Subsequently, a handful of the strongest people started to force others of the same group to yield to them. Thus, they came to possess all the wealth of society by dominating others and became the masters while treating others as slaves.

Hereon, society gave birth to two ideas. How does society run systematically? Because, of a superior master. Then, as the world is also running systematically must there not be a master? Thus, the idea of god was derived. Secondly, the idea of personal interest also came. Before this, man would think in the interest of all in the society. But, the idea of different interests of different people also came because from experience man understood that the interest of masters did not match with that of slaves. They are antagonistic. So, the idea of fate came. This is found in the literature of ancient Indian philosophy. At

its very inception, plural form such as 'we' was used, later it changed to 'I'. From then, conception of division system was introduced in the interest of a handful of people who ignored others. The idea of fate and destiny later on evolved from this.

Henceforth, fate of different classes became different. Some became rich and while others poor and oppressed. As man did not know the proper reason of emerging class division in society, they explained in their own way. The idea of fate in personal life began here. Along with a fusion with spiritual thought, this idea started to influence the human mind. The luminous stars were thought to be the soldiers of god. It was also believed that these determined the destiny of people at the time of birth. As a result, man changed his views about the stars. Before class division, man bestowed many human qualities on the stars. They did not look upon these as any supernatural objects. But, now idea began to change in tune with social change. They began to think that the stars were superior supernatural forces which could determine the future and direction of human life.

Earlier, it was the kings and the masters who were eager to know their future. The slaves did not have the opportunity to inquire about the future. Their work was determined as serving the master class. The dynasties would fight against their enemies in order to protect and expand their wealth and territories. They would appoint royal astrologers in their courts to know whether they would win or lose; who would be the successor or heir; whether male heir would be born etc. They were eager to know their future as they had to fight against the enemies to protect or expand their wealth and dynasties. The astrologers would apply zodiac concept which was already embedded in society.

From this time, astrology left its origi-

nal practice to discovering new stars and planets and it culminated in the birth of unworldly concepts like how human life is influenced etc... So, we see that in ancient times, the renowned scientist Aryabhata practiced astronomical science himself, but Varahamihira played the role of a royal astrologer in the court of King Vikramaditya. So, his 'Pancha Sidhantika' is counted as the first authentic book of Indian astrology. Thus, astrology started to determine the past present and future of human beings on the basis of the location of handful number of different stars and planets. Though astrology deviated from its original path, the term remained the same.

The people who continued the original practice of accumulating knowledge of discovering newer celestial bodies, they had to think of a name different from the original term. The branch of science which relates to the matter of cosmic world was newly named astronomy. This was the stage when astrology became stagnant. It did not include any new knowledge after this stage. The misconception which had been there in astrology persisted. But, astronomy rectified the existing flaws in astrology and expanded its perimeter of knowledge. Astrology still believes that the sun and the moon are planets. It does not have any mention of stars other than the 108 stars. Today, even a primary student knows that the earth is moving round the sun, but astrology still believes in the geocentric view.

### **Is astrology a science?**

The believers of astrology proclaim it to be a science in order make it acceptable to people. It demands that psychology or climatology is not science in the sense physics is. This is because, there are unexamined and conjectural ideas found in these branches. Astrology, though not

developed like psychology is equivalent to science in this sense. In the same way, some believers in astrology question that if it is not science then how do many predictions come out true in real life? Why do people go to the astrologers, if there is no practical basis of this knowledge?

Now the question is why do we call physics and psychology science? First of all, science does not give recognition to any sorts of myths, beliefs and ideas unexamined. Science accepts that which is well-experimented and examined with concrete proof and causalities. Science accepts that knowledge from nature which has not been developed on mere imaginations. Rather it has developed itself as common and impersonal knowledge through repeated experimentations and formulations of all operative laws and relations of nature. Thus, as per the characteristics of science, these laws and formulas are applied through repeated examinations, rectifications, inclusion and even exclusion of relatively old standing or trusted ideas or resolutions.

In any stream of science, while facing an unknown circumstance, a scientist assumes some proposals or plans of action. But, they are not accepted in science till they are not finally proved. Taking decisions basing only on the saying of a renowned scientist goes against the ethics of science. Science rather judges the accuracy of a theory in various ways and tries to determine its authenticity. Until a piece of knowledge is proved false, it is considered as a fact in science. That means when the given explanation about any phenomena stand on observed facts and can explain other events, it is called the theory of science. Science of climatology and psychology can be different in nature, but they need to follow the common characteristic of physical sciences. So, all are regarded as different streams of science.

So, can astrology be termed science in this aspect?

The development of science is through continuous experiments and gathering of knowledge. Astrology is still advocating the old obsolete notions on celestial bodies of 1500 years ago when new and modern concepts have been accepted through several discoveries replacing the old ones.

There is a co-ordination among all branches of science. They do not oppose but are conducive to each other. But in the case of astrology, when the examined and accepted astronomical notions about the sun and moon do not match with those espoused by astrology, the astrologers do not pay attention or rethink. Therefore it is considered as stagnant knowledge in the history of development of knowledge. Astrology therefore cannot be called science since its basis is mere imagination.

### **Does astrology have any Vedic version?**

Now let us examine whether applied astrology have any Vedic version. Previously we have mentioned the first authentic book on astrology, the 'Pancha Siddhantika' written around 700-800 AD. It is no doubt that the period mentioned is centuries after the Vedic Age. No books on applied astrology are found dating from the Vedic Age.

So, what existed during the Vedic Period? In that period, astrology meant what astronomy means today. Like other ancient civilizations, man in the Vedic period also tried to determine the location of several cosmic bodies. Although, in other civilizations, astronomy was practiced in respect of expanding mainly the agricultural-based economy, in the Vedic civilization, it was related to the development of economy based on domestication of animals. So, in our country, people tried to determine the location of stars and planets for different



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programmes and it was conducive to the development of astronomy. For carrying out these sorts of programmes, the use of year-book or almanac was mandatory. In the age of Brahambanas, 'yotish' was known as a particular subject. In the literature of Brahambanas, 'yotish' was called the study of stars and the astrologers (read astronomers) were called Ganaka. At first, the almanac was made considering one month as comprising thirty days, one year as three hundred and sixty days, even as thirteen months. This thirteenth month is called 'malmasa'. It was a way of keeping balance between lunar year and solar year.

In the Vedic Age, the lunar month which started from the full moon was used for calculating a year. The last day of a year was the full moon when the location of the moon with that of a particular constellation of stars called 'purva falguni' and the location of the sun was on the Tropic of Capricorn. The next day was the first day of the new year of the month of Falguna. Some years consisted of 13 months.

A year was divided into two parts. The first part was summer solstice that marks the journey of the sun from the Tropic of Capricorn to the Tropic of Cancer and the second was the winter solstice marking the solar journey from the winter solstice to again the summer solstice after circumambulation of another six zodiacs. In 'the Satapath' and 'Koushitaki Brahmanas', celestial points, summer and winter solstices were mentioned and discussed also. They were also often observed by the sages of this age. So, it is clear that people of the Vedic Age were well acquainted with zodiacal signs. In a hymn in the Rig Veda, the course of the sun in the sky has been compared to the wheel of twelve spokes. As per the analyst, Sayan, the twelve spokes are nothing but the twelve symbols of zodiacal signs.

Zodiacal signs and their divisions were designed following the apparent course of the sun. This was so for the moon also. In 'khagol', the celestial spheres of the sun and the moon are more or less same. So, it is very easy to calculate the course of the moon with the location of the stars under the celestial spheres. The Chinese divided the celestial bodies into 28 parts of stars. The Vedic saints divided it into 27 parts with 27 luminous stars. They were named in the Vedic Age. The name of 'magha' and 'falguni' has been mentioned in the Rig Veda. In 'Taittiriya Sanhita' the name of 27 stars has been mentioned. These names prevail even today in the books of astronomy.

From the next day of the full moon, the months were treated as lunar months. The name of a month was given in the name of the star which marked the end of the full moon. Such as, baisakha, kartika start after the end of the full moon of Bishakha and Kritika stars. Later, new months were introduced as solar months replacing lunar months, but the names given on the basis of lunar month remained unaltered.

Since the time of the Rig Veda, Indians were acquainted with 7 planets. Some of them carried Indian names such as Mangal, Brihaspati and Sukra. The moon has no light of its own. The source of light of the moon is the sun. This idea might have existed in the Vedic Age. At least, the conception of the relation between the sun and the halo of the moon prevailed in those times. In 'Satapath Brahmanas', the earth has been described as 'Parimandala' (constellation). Therefore, many think that in that age, the idea of revolution and rotation of the earth were assumed.

We have discussed so far about space, planets and stars as was thought about by the people of the Vedic Age. First of all, there is a direct attachment of astronomy

with the idea that people fostered, it is not that of applied astrology. The idea of determining the future of an individual on the basis of the location of stars and planets were absent then. Secondly, there was no fundamental book on astrology (read astronomy) during that time. The various astronomical concepts were amalgamated with different hymns and verses of the Veda. In this subject, 'the Vedanga Jyotish', the most ancient book written between 600 BC and 200 AD was no doubt a precious collection of the study of space science. But, it does not have any relation with applied astrology. This book is treated as an almanac in the Vedic Age. Even during that time, at the summer and winter solstice points, the location of the stars named 'Aslesha' and 'Dhanistha' was mentioned. The study of planets was highly developed. The idea that those planets and stars were not the same cosmic body was known at that time.

So, it is clear that the existence of Vedic astrology is not found. Firstly, no book is exclusively written on astrology then. Secondly, the practice of applied astrology started in 6th century BC, not in the Vedic Age. Thirdly, it is based on unscientific notions. So, the practice of applied astrology makes us superstitious and victims of blind faith in spite of development of rational thinking.

### **Why do people believe in astrology?**

It is very significant to raise the question that if it is not fruitful to human life, why do people believe in it? It is a fact that a significant number of people from all strata have faith in it. Wearing several rings, some of them perform scientific experiments in laboratories and discuss about modern developments in scientific inventions. Even a section of astronomers believe in this irra-

tional unscientific practice. The question like, why it is so engraved in our society, cannot be left unanswered. So we need to pay attention to the psychology of society nourishing all these false ideas and come out with a critical explanation of socio-economic factors behind it.

It has been shown that society was divided into two parts i.e. exploiting class and the exploited one, in the course of social development giving birth to the sense of personal property and other individualistic ideas. In this course the fate of human lives became different for different individuals. It is precisely here that astrology had begun to build its foundation in our society. Unfortunately, even in modern times, filled with unprecedented scientific and technological developments, most of the people in our society are still ignorant of the reality that society is class divided and its impact. As a result, man seeks to explain the reason behind inequalities with the concept of various supernatural forces conjured up by their imaginations. Thus, existence of class division is the main social factor for the presence of astrology in the society.

It is true that due to the progress of modern science and rapid advancement of production system, the hoard of knowledge of human being as well as quality of his life style has increased manifold. But, the fruit of this advancement has not reached down to the poorer sections of people. They are compelled to lead subhuman lives. Why?

The workers and peasants of the society who involve in our production system to produce commodities are considered the most insignificant section of the society. They are kept at a distance from enjoying the fruit of advanced modern production system. Unfortunately people do not know the reason behind this condition. So they depend on their own individual thoughts

which are derived from blind faiths through ages. Another point to be remembered is that the progress of history and social sciences is not in proportion to the growth rate of advancement of natural sciences. But, history and social science are much more important as yardsticks for measuring the human view point of the progress of society than natural science.

What is the present socio-economical aspect of human life? Day by day crisis is increasing. A father is not certain whether his children would get proper education. A member of a lower middle class family does not go for any treatment when he is ill, thinking it as his fate. An educated youth who has passed engineering having spent lakhs of rupees remains unemployed. A worker is under constant threat of being fired or locked out. Everywhere, uncertainty permeates.

But, why does this condition persist? Why does this hapless condition get intensified in the lives of common people with the simultaneous growth of science and technology? The common people are unacquainted about reasons responsible for their condition. So, they resort to some false ideas. They think, fate, cruel destiny are responsible. They think that all these troubles of life are one's personal matter and can be solved only by changing one's fate and destiny. As he is enslaved by his daily drudgery, he cannot think of a new society which not only will ensure abundant supply of essential requirements, but also set a suitable atmosphere for personal development, ensuring education, health, proper employment, security for aged people and so on. In that society, all the people will be able to build their own futures instead of putting faith on nonexistent mystical spiritual forces.

It is obvious that predominance of an uncertain life and people's ignorance about

its cause has given birth to astrology and, so far, has kept it still thriving as a disseminating social base. Besides, prolonged and extreme effect of superstitions, crisis of secular, scientific education, and absence of genuine scientific outlook, even in educated people, has helped it to dig deep roots in the society. Therefore, people continue to associate Jupiter with good and Saturn with bad. In this connection, people are seen keeping trust in a tiny creature such as a parrot and wearing special ornaments to protect themselves from the malignant influences of the planets far away. They wear amulets around their necks, waists and rings on fingers throughout their lives.

### **How will people stop believing in astrology?**

The answer is simple. The factors which help people believe in astrology intensely must be obliterated. With the growing uncertainty in society, people lose faith in themselves and start believing in astrology. The same phenomenon, perceived throughout the ages is still continuing today. Only an objective condition conducive to build up a scientific and a rational bent of mind can change the prevalent 'faith based' thinking. This change in the thought process from irrational, unscientific to a much more logical and rational one is imperative and crucial.

Unfortunately, the very opposite is being applied in our society. An attempt to induce the faith based thought system is deliberately being implemented in the education system and even through the media. Whereas higher education is being curtailed day by day, the implementation of this irrational faith-based system will no doubt serve as the barrier in proliferation of scientific and rational thought amongst educated people because through our education system, syllabi, teaching and ex-

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- Astrology is an aesthetic affront. It cheapens astronomy, like using Beethoven for commercial jingles.
- Faith is a great opt-out, the great excuse to evade the need to think and evaluate evidence. Faith is belief in spite of, even perhaps because of, the lack of evidence.

Richard Dawkins

amination processes, a student will be able to learn only formulas and information but will not be taught to analyse cause-effect relation behind all things. So, people who have wide range of knowledge of the facts and figures of science are seen believing in age old blind faiths and superstitions. Besides astrology, Vedic mathematics is being introduced in syllabus on the pretext of learning Indian culture and heritage. Advertisements of astrologers are rampant in TV and newspapers, to the extent that many television channels are solely dedicated to airing shows on practice of astrology. These joint endeavors of these vicious agencies are entrenching these reactionary thoughts in the minds of people.

In order to purge this process of indulgence in false beliefs completely from our minds, we need to build up a strong anti-current of movements to ensure an amount of certainty in our lives. Simultaneously we should take initiative to build up science movements to cultivate scientific approach and scientific temper among people across the country in order to transform the present rigid thought process into a living thought process. The strength of these movements can only determine how soon we will be able to uproot all these harmful faiths like astrology from our society. □

*(Continued from page 21)*

On the other hand, Sudarshan has never missed an opportunity to make public his frustration. Robert Marshak, Sudarshan's supervisor and co-author has vividly described the circumstances and has owned up the three blunders he had committed that led to Sudarshan's major scientific discovery of V-A theory being not given its due [1]. About the 2005 Nobel Prize, Sudarshan himself wrote to the Nobel Committee, "I am therefore genuinely surprised and disappointed by this year's choice. It would distress many others and me if extra-scientific considerations were responsible for this decision" [2].

There is a strong opinion among the physicists that Sudarshan should have shared the prize with Glauber. We may speculate about the reasons why Sudarshan was denied the Nobel prize, but that will serve little purpose. In an article published in 'The Guardian' in 2010, British scientist Sir Harry Kroto, winner of the 1996 Nobel prize for chemistry is quoted as saying that he believes 'A Nobel is not just an award for a piece of work but is a recognition of a scientist's overall reputation'. It is possible that Sudarshan's 'not-so-scientific' attitude in some issues has stood in his way of getting a Nobel prize. Still, Sudarshan's contribution to science will always be treasured by scientists. As Sudarshan himself said, "I don't do research for a Nobel, I do it because I enjoy the process." □

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# March for Science 2018

## A report

India joined the International March for Science on April 14, 2018. Scientists, researchers, teachers, students and science loving people in thousands across the length and breadth of the country joined hands to defend science and scientific temper. Marches were organised in more than 40 cities and towns in India. Marchers carried colourful placards and banners displaying slogans “Spend 3% of GDP for Science!”, “Spend 10% of GDP for Education to Educate the Next Generation!”, “Stop Spreading Unscientific Beliefs!”, “Science Not Silence”, “Science Belongs to Everyone”, “Science + Myth a dangerous mixture”, “Defend science do not defund science”, “Science Unites”, “Science for Society, Science for Man, Science in Thinking!” etc. People everywhere were enthused seeing a march for science and education. The march symbolised the unity of the scientific community which is the need of the hour to fight the present crisis facing science in India.

### Reports from different cities and towns

#### Delhi

Scientists, professors, scholars and students numbering more than 400 from DU, JNU, AIIMS, IIT-Delhi, CSIR-IGIB, Aditya Paramedical Institute, Ambedkar University and various other institutions in Delhi participated in the March for Science. The march started from Mandi House at 3:30 pm and ended at the Parliament Street.

At the Parliament Street the rally was addressed by Prof. Dhruv Raina (Professor, School of Social Sciences, JNU), Prof. Jayashree Sengupta (Former Professor and Head, Dept of Physiology, AIIMS), Prof D Raghunandan of AIPSN and several others.

#### Mumbai

In Mumbai the march for science was from Nehru Planetarium to Haji Ali Chowk. With around 350 participants from different institutions including TIFR, IITB, TISS, CEBS, BARC, the march was a big success. Follow up programs taken after the event of IMFS, 2017 had greatly contributed to the success of the march. Prof. T Jayaraman (Tata Institute of Social Sciences, Mumbai), Vivek Monteiro (Navnirmithi, an organisation that promotes scientific thinking and innovation) and several others addressed the marchers.

#### Kolkata

At the call of the March for Science Kolkata Organizing Committee, scientists, teachers, research scholars, students, and science loving people started pouring into the Ramlila Park near Moulali, Kolkata by 1pm on April 14, 2018. Prof. Amitava Datta presided over the meeting. Prof. Soumitro Banerjee addressed the gathering and explained the objectives of the ‘March for Science 2018’. He reiterated that the unity of the scientific community is the need of the hour to fight the present crisis and to guide the MFS movement in the

## News & Views



March for Science at Delhi

right path. Prof. Nabakumar Mandal, internationally renowned particle physicist, flagged off the march. Scientists, teachers, research scholars and students in thousands marched towards Esplanade. At the conclusion of the march at Esplanade, Prof. Amitabha Datta, chairman of the advisory committee, briefly addressed the gathering. A four member delegation from the MFS organising committee submitted a memorandum addressed to the Prime Minister of India to the Governor of West Bengal.

### Chennai

The march for science at Chennai began around 7AM from the north end of the Elliots beach, Besantnagar. The march was flagged off by Prof. R Ramachandran, former director, Institute of Mathematical Sciences, Chennai. Hundreds of students, teachers, scientists and other science loving people holding placards displaying the demands, participated in the march with great enthusiasm. The dignitaries who addressed the gathering were Prof. Mohana, president, Tamilnadu Science Forum, Prof. T R Govindarajan, Chennai Mathematical Institute, Mr. Ilango Subramanian, Newton Science Club, Prof. J. Gandhiraj, president, Association of University Teachers (AUT), Dr. S H Thilagar, Vice President, Break-

through Science Society, Tamilnadu and Dr. Uma Ramachandran, convener, March for Science Chennai organising committee.

### Bengaluru

On the 14th of April, around 4pm, hundreds of scientists, research scholars, lecturers, academicians and students gathered at 18th cross college grounds in Malleswaram to stand up for science, celebrate science and defend science. Floral tributes were paid to Prof. Stephen Hawking and Prof. J.R.Lakshman Rao. The dignitaries who addressed the gathering included Prof. Sharbari Bhattacharya (Dept. of Physics, Bangalore University), Mr. Nagesh Hegde (popular science writer in Kannada), Prof. S Mahadevan ( IISc, Bangalore), Prof. Ramesh Londonker (Gulbarga University) and Dr. Sudha (senior plastic surgeon). Hundreds of people who had gathered along with the scientists and activists, formed a 'Human Chain' starting from Malleshwaram 18th Cross, expressing solidarity for the science movement happening across the world.

### Thiruvananthapuram

In Thiruvananthapuram the march for science began from the 'Institution of Engineers' building compound, opposite

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March for Science at Mumbai

Kanakakunnu palace , at 10.30 am on April 14. Shri D.Krishna Warriar, former deputy director, C-DAC and chairman, 'March for Science Trivandrum organising committee', inaugurated the march. Hundreds of people comprising of scientists, research scholars, teachers, students and concerned citizens actively participated in the march. The march culminated in front of the Kerala University office, Palayam, where a brief meeting was held. Shri. D.Krishna Warriar, Prof. C.P.Aravidakshan, Shri. B.Ramesh (Vice President, Kerala Sasthra Sahithya Parishath), Shri. G.S.Padmakumar (President, Breakthrough Science Society) and Shri. Sreerag (Secretary, Aastro Kerala) spoke at the concluding function. Prior to the march, a seminar was held at the Institution of Engineers Hall. Dr. Umesh R Kadhane, IIST, Trivandrum delivered a lecture titled 'Building a Scientific Young Mind: Why and How?'

### Hyderabad

The march for science in Hyderabad began from Basheerbagh press club. At the start of the march, homage was paid to the eminent scientist Stephen Hawking. Dr. M R Vishnu Priya (Principal Scientist, CCMB) flagged off the march. Students, teachers, researchers and scientists numbering more than 400 participated in the march. The rally ended at the Liberty Circle and a

meeting was held in a hall. The speakers who addressed the meeting were Dr. M R Vishnu Priya , Dr. P.V.Nagendra Kumar, Prof. S.Bakhthiar Choudhary, Shri. J.Sastry Garu, Shri. R.V.Nathanial, Dr. Krishnakumari Challa, Dr. K. Babu Rao, Dr. G.Rajitha, Prof. K.Janibasha, Shri. D.Gangaji and Shri. R.Gangadhar.

### Chandigarh

The 'March for Science 2018' in Chandigarh was jointly organized by scientists from IISER Mohali, Punjab Central University and NIPER. The march started at 6:00 PM from Punjab Central University and ended at Sector-17 Plaza. The gathering was addressed by Dr. Ritajyoti Bandyopadhyay, Dr. Esha Halder, Dr. Amol Amodkar, Dr. Kala G. Pradeep from IISER and Dr. Vijay from Punjab Central University. The march attracted large crowds when it passed through three consecutive market places.

### Ahmedabad

In solidarity with the 'Global March for Science' on April 14, scientists, eminent citizens, academicians, students and science loving people organised a 'Human Chain' at Vallabh Sadan, Delite cross road, Ahmedabad from 5.30 to 6.30 PM. The dignitaries who participated included Prof. Raghavan Rangarajan (Ahmedabad Univer-





March for Science at Kolkata

sity), Dr. Dipaniben Sutaria (Ecologist, CEPT University) and Shri. Manishibhai Jani (Gujarati Lekhak Mandal). Research scholars, students and teachers from various institutions including PRL, Ahmedabad, Institute of Seismological Research, Gandhinagar, participated in the march.

### **Rohtak**

A march for science was organised at Rohtak on April 14 under the banner of 'March for Science Haryana Organising Committee'. The march began at 10 AM from Post Graduate Institute of Medical Sciences (PGIMS) and culminated at Maharshi Dayanand University, Rohtak. A good number of school students, medical students and researchers joined the march. Dr. Umesh Kumar (MD University), Dr. Priyanka Saini (PGIMS), Dr. Vedpal Deshwal, Mr. Basant Lal, Mr. Avdhesh Kumar, Mr. Chanchal Ghosh and Mr. Harish Kumar addressed the gathering.

### **Bhopal**

The 'March for Science Madhya Pradesh Organising Committee' held a hall meeting on April 14 at Gandhi Bhawan, Bhopal. Students, professors, scientists and science

loving people from Bhopal as well as other districts like Gwalior, Guna, Ashok Nagar and Indore took part in the program. Dr. Parimal Mishra, Dean of Reddy Institute of Life Sciences was the main speaker. After the hall meeting, a rally was taken out from Gandhi Bhawan to Polytechnic Square. Mr. B R Raghuvashi from B R Academy, Mr. Sunil Gopal and Mr. Vikas Bansal from Breakthrough Science Society addressed the gathering at the conclusion of the march.

### **Bhubaneswar**

On April 14, 9AM scientists, teachers, research scholars and students from different institutes and universities gathered in front of the Sainik School. A well decorated march with colourful posters moved through the Institute of Physics, the Institute of Materials and Minerals technology and reached in front of Utkal University, where a mass meeting was held. Prof. Birendra Nayak (Retd.), Dept of Mathematics, Utkal University presided over the meeting. Prof. Biju Raja Sekhar, Prof. L. P. Singh, Mr. Gobardhan Pujari, Dr. Kanta Das Mohapatra and Dr. Sidhartha Varadwaj addressed the gathering.



## News & Views



March for Science at Thiruvananthapuram

### Guwahati

In Guwahati the participants of the march for science assembled at the Cotton University gate at 12:30PM. Ms. Ramyani Chakrabarty, Convenor of Assam organising committee, explained the objectives of the march. The march was flagged off by Dr. Kulendu Pathak, eminent educationist and former VC of Dibrugarh University. The well decorated rally with banners and placards culminated at Guwahati Club, where a brief meeting was held.

Dr. Apurbalal Senapati, CIT Kokrajhar addressed the gathering. Many faculty members and research scholars of IIT Guwahati who were unable to join the march that took place in the city, gathered at IIT Guwahati main gate and expressed their support for the 'March for Science'.

### Agartala

On 14 April 2018 at 3PM participants of the 'March for Science' assembled in front of Rabindra Shatabarshiki Bhawan, Agartala. Dr. Alak Satpathi, Associate Professor of Physics, BBM College, addressed the gathering. Dr. Mridul Pal, scientist and Dr. Rabi Sarkar, agriculture scientist also spoke. After the meeting the march started and passing through several parts of the city it culminated at Swami Vivekananda sports ground. Hundreds of research scholars, teachers, and students took part in the march.

### Patna

On April 14, 2018 morning scientists, professors, doctors, research scholars and science loving people assembled at NIT More,



Demonstration in support of the March for Science at Barcelona, Spain

## News & Views

Patna. The march began at 10AM and proceeded to Gandhi Maidan where a meeting was held. Eminent Persons who addressed the gathering include Prof. Santosh Kumar, Prof. Bharti S Kumar, Prof. Ramashankar Arya (Ex. Vice Chancellor, VKS University), Prof. Tapai Mukherjee, Prof. Arun Kumar (General secretary, AIFUCTO), Dr. P N P Pal, Col. Dr. Ahmed Ansari, Dr. Diwakar Tejaswi, Mr. Sunilkumar Singh, Mr. Santosh Kumar (Gyan Vigyan Samiti, Bihar), Mr. Joseph John, Director, St. Mary's High School, Patna and Mr. Umesh Pandit (Science for Society).

### Pondicherry

In Pondicherry the march for science began at 4PM from the head post office and culminated at Gandhi Mandapam. Students, teachers, scientists and general public numbering more than 200 participated enthusiastically in the march. Mr. Prasanna G S (Pondicherry Science Forum), Mrs. Hemavathy (HM, Savary Rayalu Higher Secondary School) and Mr. Ravi from Breakthrough Science Society addressed the gathering.

### Jamshedpur

On the 14th of April, 2018, braving the hot weather, science enthusiasts gathered in big numbers at the Graduate College, Jamshedpur and marched to Sakchi Golchakkar raising the demands of the 'March for Science'. Dr. Sailendra Asthana (Principal, Jamshedpur Workers College), Prof. Amitabh Bose, Prof. Kiran Sukhla and Mr. Kanay Barik (Breakthrough Science Society) addressed the gathering at Sakchi Golchakkar.

### Other Places

'March for Science' programmes were also held in several other towns across the



March for Science in Chennai

country.

Kerala: Kollam, Thrissur, Palakkad, Allapuzha, Ernakulam, Pathanamthitta, Thodupuzha, Kottayam, Malappuram and Kannur. Tamilnadu: Madurai. Andhra Pradesh: Anantapur, Tirupathi, Nellore, Kurnool and Visakhapatnam. Assam: Silchar. Chattisgarh: Raipur, Bilaspur and Durg. Jharkhand: Bokaro and Hazaribag. Odisha: Brahmapur, Rourkela. West Bengal: Siliguri, Coochbihar, Balurghat and Baharampur.

### Solidarity from abroad

In solidarity with the 'March for Science' in India, 250 Indian scholars organized demonstrations in 37 cities across 18 countries. It was an extraordinary effort which depicted the importance and uniqueness of this march. No matter where Indian scholars stay, they did understand the necessity of this march and extended their support to the demands raised by the 'March for Science' in India.

The list of countries and the cities (in bracket) where the marches were organised: Austria (Vienna), Belgium (Ghent, Louven), Brazil (Santa Maria, Natal), Canada (Vancouver, Waterloo), Finland (Oulu), France (Paris, Besancon), Germany (Erlangen, Stuttgart, Munich, Ulm, Dresden), Israel (Tel Aviv, Negev, Weizmann/ Rehovot), Italy (Padova,

Trieste, Rome, Naples), Mexico (Leon), Netherlands (Eindhoven), Poland (Gdansk), South Korea (Pohang, Suwon), Spain (Barcelona, Madrid), Switzerland (CERN, Geneva), Taiwan (Taipei, Kaohsiung), USA (Tempe/ Arizona, Tallahassee/ Florida, College Station/ Texas, Buffalo, Dartmouth/ Hanover).

### Messages from eminent scientists

**Prof M S Swaminathan**, Eminent Agricultural Scientist

“Jawaharlal Nehru used to say that ‘the future belongs to science and those who make friendship with science’. Science in a broad sense is search for truth”. Understanding of science helps to improve the quality of one’s life. Science is basic to progress in all areas of human activities. I am therefore happy that a *March for Science* is being organised on April 14th. I hope this will create an atmosphere of science for all, whether young or old, whether rich or poor, whether man or woman. The onward march of science is basic to solving the problems of hunger, poverty, unemployment and disease. I therefore plead for the widespread participation in the ‘March for Science’.”

**Dr M Anandakrishnan**, Former Vice Chancellor, Anna University, Chennai

“I wish to complement the organizers of the March for Science on 14 April 2018. The goals of the march to plead for 3% of GDP for Science and 10% of GDP for Education are indeed laudable. More commendable are the insistence to create a society with scientific temper devoid of superstitions.

Unfortunately the recent trends in India for development of education and science

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are highly disappointing. The last budget of the central government doles out lavish increases for space, biotechnology, and renewable energy but very little for research in other scientific areas. India's nuclear program didn't get the raise it was hoping for. While the nuclear power expansion plans will stay intact, nuclear research will suffer. In the budget proposal released, Council of Scientific & Industrial Research (CSIR), which runs 38 labs, is slated to receive slightly more than a 3% increase. The contribution of private sector for scientific research is dismal.

At the annual science congress last January, Prime Minister Modi exhorted Indian scientists to help the nation become one of the world's top three science powers by 2030. The 2017 science budget won't propel India far along that road. India has been stuck for years with 0.9% of GDP spending on S&T, which is far less than 2% spent by China. The national ambition to attain high economic growth and to become globally competitive remains a dream. The need to induct school children in the ways of science is yet to find root.

Under these circumstances I hope that the 'March for Science' will evoke public awareness and support."

**Dr Dipankar Chatterji**, Honorary Profes-  
sor, Indian Institute of Science, Bengaluru

"This is an excellent and just issue on which today's programme is arranged. We all have assembled here to reaffirm our faith on science and rational way of living. We are here not to criticise any one or discuss the nature of science administration. Rather we would like to emphasise that no country in the history of human existence has become successful devoid of scientific methods. Irrational way of thinking is in fact a clear way to exploit the poor and the downtrodden. Let us together avoid that apocalyptic end."