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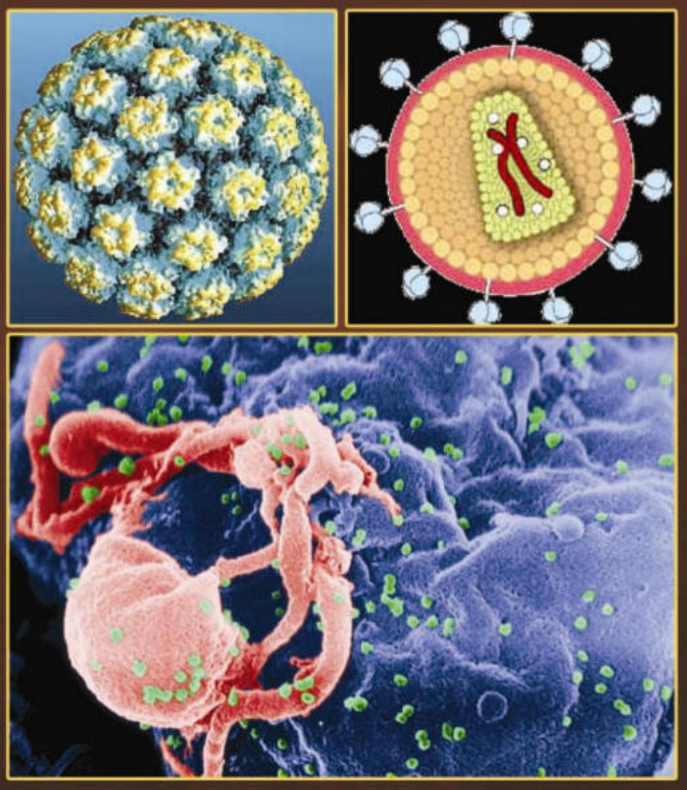
Taming Killer Viruses

Harald zur Hausen



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

In Search of Other Earths

Are we alone? Humans have pondered over this question for centuries. Scholars have speculated, and continue to speculate, that Earth-like planets must exist and harbour life – at least some form of life - elsewhere in the universe. Considering that there are 100 billion suns in our galaxy, and our Galaxy is only one of a 100 billion other galaxies; and that the cosmos is much older than the solar system, it is quite likely that life could have started elsewhere much earlier than on Earth.

It is interesting to note that in recent years the discovery of organic molecules and amino acids in molecular clouds deep in space, meteorites and comets suggest that at least low-level life-forms, given the right place, may be quite common in the universe. Further, life appears to be much more robust than previously thought. Bacteria have been discovered several kilometres below the Earth's surface that thrive only on the minerals in the rocks. Deep in ocean, life-forms have been found feeding on the sulphur spewing from hot, almost boiling vents and at great pressures. We could thus expect life forms that could have evolved even in completely different ways depending on the physical conditions existing on the planets orbiting other stars.

Ever since the suggestion by Philip Morrison and Giuseppe Cocconi in 1959 that radio waves could be used for detecting signals from our likely cosmic counterparts, and the very first experiment run by astronomer Frank Drake in 1960 at the Green Bank radio telescope facility in West Virginia, USA, the search for extra-terrestrial intelligence (SETI) has continued in full swing. Today it is an international effort by several groups. SETI involves looking for potentially artificial signals amongst the myriad of signals coming from outer space. Indeed, it is like trying to find a tiny *intelligent* needle in a vast cosmic haystack. SETI does not send signals into space; it only listens. Intelligent life, if it were interested in communicating with us, would have to send signals which are distinguishable from other sources, and the signals would have to be *deliberately* beamed towards us.

Could Earth-like planets exist? The search for extra-terrestrial life received a boost with construction of large telescopes, progress in imaging technology, and Earth-orbiting space telescopes during the past two decades. With the discovery of about 350 planets orbiting other stars since 1995, the centuries-old quest for other worlds like our Earth has been rejuvenated. Indeed, several stars have been discovered with planets orbiting them. Our solar system is thus not unique. *Exoplanets*, as they are called, appear to be common in our galactic neighbourhood. However, the ones discovered so far are mostly gas giants with characteristics similar to Jupiter and Neptune. If we could discover smaller, terrestrial planets like Mars and Earth, there is greater chance that we may detect life on them. Indeed terrestrial planets are extremely difficult to detect due to their small size and proximity to the bright stars they orbit.

Only recently has the *Convection Rotation and Planetary Transits Space Telescope* (*CoRoT*), launched by European Space Agency in 2006, found the smallest terrestrial planet ever detected outside the solar system. The amazing planet is less than twice the size of Earth and orbits a Sun-like star. Its temperature is so high that it is possibly covered in lava or water vapour. It further strengthens our belief in possible existence of Earth-like planets and life in other regions of the universe. Over the next 15 years, NASA is embarking on a bold series of missions to find and characterise new worlds. These missions will have the most sensitive instruments ever built, and will be capable of reaching beyond the bounds of our own solar system.

How do we detect the exoplanets, anyway? Planets found around the nearby stars have been discovered only indirectly, never seen. This is essentially because planets do not produce any light of their own (except when young). Next, they are at an enormous distance from us; and they are lost in the blinding glare of their parent stars. If so, how could we detect them? One way is to precisely measure the radial velocity or change of position of stars. A star with a single planet both move about their common centre of mass. If we are observing the spectrum of the star, it appears to shift towards the red end when it is moving away from us and towards the blue end when it is moving towards us as a result of Doppler Effect. This tells us the extent of the star's movement induced by the *planet's* gravitational tug. From that information, one can deduce the planet's mass and orbit. In a method called the astrometric method, the slight motion of the star caused by the orbiting planet is accurately measured. In this case, however, astronomers search for the tiny displacements of the stars on the sky. Yet another method, the transit method, utilises the fact that if a planet passes directly between a star and an observer's line of sight, it blocks out a tiny portion of the star's light, thus reducing its apparent brightness. Many of us would immediately recall the phenomenon of Mercury or Venus transit, and how the planet blocks the part of the Sun during its passage across the disc of the Sun. Sensitive instruments can detect this periodic dip in the brightness. Finally,

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Arthur Stanley Eddington

Who Pioneered the Study of Internal Structure of Stars

☐ Subodh Mahanti
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I believe there are 15 747 724 136 275 002 577 605 653 961 181 555 468 044 717 914 527 116 709 566 231 425 076 185 631 031 296 (136×2^{256}) protons in the universe and the same number of electrons.

Eddington in Tarner lecture (1938)

"Eddington's work has opened up the interior of the stars to science. The science of astrophysics, ie, the study of the inner as well as the outer nature of the stars, takes increasing precedence of astronomical investigation. Its latest development is so intimately connected with modern astrophysical problems that it can hardly be treated in adequate manner as a piece of history."

A. Pannekoek in *A History of Astronomy* (1989)

"Eddington wrote a number of books for both scientists and laymen. His more popular books, including *The Expanding Universe* (1933), were widely read, went through many editions, and opened new worlds to many enquiring minds of the inter-war years. It was through Eddington that Einstein's general theory of relativity reached the English speaking world."

A Dictionary of Scientists, Oxford University Press (1999)

Arthur Stanley Eddington was the most distinguished astrophysicist of his time. He pioneered the study of internal structure of stars. He discovered the fundamental role of radiation pressure in the maintenance of stellar equilibrium. He realised that there was a limit to the size of a star. He also explained the mechanism by which energy of a star moves from its inner parts to outer parts. He discovered the mass-luminosity relationship for a star. This relationship shows that the more massive a star the greater its luminosity. The significance of this relationship is that it allows the mass of a star to be determined if its intrinsic brightness is known. This discovery forced a complete revision of contemporary ideas of stellar evolution. He was a foremost supporter of Albert Einstein's theory of relativity. Einstein himself considered Eddington's treatise on relativity published in 1923 to be the best written in any language.

Eddington was a great science populariser. In fact his popular science writings made him a household name in England between the two World Wars. He gave numerous lectures, interviews and radio talks on difficult and abstract subjects like relativity and quantum mechanics and made them understandable to laypersons. Later his lectures were compiled into book forms.

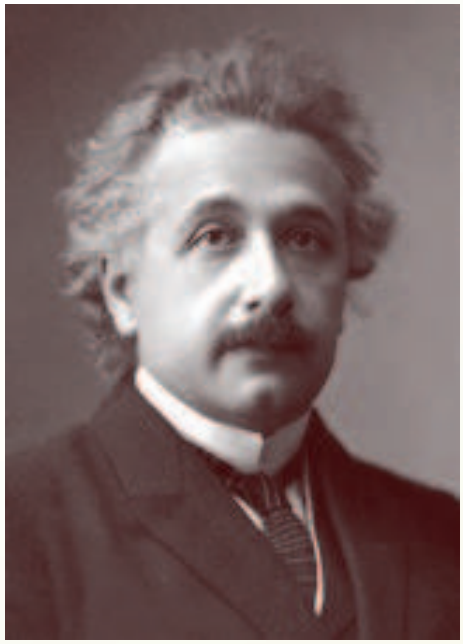
Eddington did not believe that science would be able to provide proof for religious propositions. Though, he argued for a deeply-rooted philosophical harmony between scientific investigations and religious mysticism.

Arthur Stanley Eddington

Eddington is also known for his famous dispute with Subrahmanyan Chandrasekhar, who was then a student of Cambridge University. This incident portrayed Eddington as cruel and dogmatic, a personal trait that was unknown to many of his contemporaries. Perhaps Eddington could not believe that a mathematical theory derived from quantum mechanics was enough to explain the inherent extreme physical situations of degenerate stars.

Summarising the achievements of Eddington, the obituary in *The Times* noted: "He (Eddington) was a gifted astronomer whose original theories and powers of mathematical analysis took his science a long way forward; he was a brilliant expositor of physics and astronomy, able to communicate the most difficult conceptions in the simplest and most fascinating language; and he was an able interpreter to philosophers of the significance of the latest scientific discoveries."

Eddington was born on 28 December 1882 in Kendal, England. His parents Arthur Henry Eddington and Saran Ann Eddington, were Quakers (members of the Society of Friends, a Christian



Albert Einstein

denomination founded in England around 1650 by Georges Fox). His father taught at a Quaker training college in Lanchashire before he moved Stramongate School at Kendal as its Headmaster. It may be noted that English chemist and physicist John Dalton (1766-1844) taught at Stramongate School. After Eddington's father's death in 1884 the family moved to Weston-super-Mare.

After spending three years in a preparatory school, Eddington entered the Brynmelyn School. In his school he proved to be an exceptionally brilliant student, particularly in mathematics and English literature. Based on his outstanding performance he was given a scholarship for studying at Owens College of Manchester University. where after studying the general course for a year he turned to physics. During his college days he was greatly influenced by Horace Lamb (1849-1934), who is most known for his work on fluid mechanics, Arthur Schuster (1854-1934), and John William Graham, a Quaker mathematician.

In 1902, Eddington graduated with a BSc in physics with a First Class Honours. Based on his performance he was given a scholarship, which enabled him to study at Trinity College, University of Cambridge. After obtaining a BA degree in 1905 he started doing research on thermionic emission at the Cavendish Laboratory. His progress in research was not satisfactory. He started teaching mathematics to first-year engineering students but he did not enjoy it. Fortunately he did not continue long at the Cavendish Laboratory. He left Cambridge in 1906 to join the Royal Greenwich Observatory as Chief Assistant to the Astronomer Royal. Here he got involved with a project that had started in 1900 and called for the analysis ofphotographic plates of Eros taken over the period of a year. Eddington's task was to determine an accurate solar parallax from these photographic plates. To do that he developed a new statistical method of analysis of two star-drifts. His essay on the proper motions of stars won him the Smith's Prize in 1907. The same year he became a Fellow of the Trinity College.

In early 1913, Eddington became the Plumian Professor of Astronomy and Experimental Philosophy at Cambridge University. He succeeded George Darwin, son of Charles Darwin (1809-

John Dalton

1882), the originator of the theory of evolution by natural selection. George Darwin had died in December 1912. In 1914 Eddington became the Director of the Cambridge University Observatory.

As mentioned earlier, Eddington pioneered work on the internal structure of stars. His works in this field were compiled in his classic work, *The Internal Constitution of Stars*. Radiative equilibrium formed the central theme of Eddington's work. In 1905, German astronomer Karl Schwarzschild (1873-1916) proposed a theory of the Sun's atmosphere. It was based on the principle of radiative equilibrium, which assumed that temperature at any point is the result of the radiation it received from all directions as the chief mechanism of heat transfer at such high temperatures. Schwarzschild's theory made the cloud theory of the photosphere irrelevant, as temperature and density increased towards the centre. Before Eddington, attempts were made to account for the internal structure of stars. For example, Swiss-born German physicist A. Ritter carried out theoretical investigations during 1878-83 for obtaining results about the internal structure of the Sun. However, when Ritter was working, the concept of radiation was unknown to physicists and so Ritter's approach lacked the right basis. In 1907, Swiss astrophysicist Robert Emden (1862-1940) developed a general numerical theory of gaseous sphere in space, applicable to Sun and stars. But Emden also had no idea on any other mechanism of heat transfer other than convection and conduction. So he also failed to make any

Subrahmanyan Chandrasekhar

breakthrough. Eddington in his attempt to understand the internal structure of stars not only extended Schwarzschild's earlier work on radiative equilibrium but also made use numerical computations of Emden. In doing so Eddington made a real breakthrough. Now it was possible to calculate the physical conditions (temperature, density, pressure, ionisation and coefficient of absorption) at any given point of the interior of a star as a function of its distance from the centre.

In Eddington's interpretation three new points of view were introduced. First, the radiative pressure can carry a significant part of the weight of the matter in the stars. Second, the high degree of ionisation is caused by highly intense radiations. Entire electron shells of atoms are torn apart and a situation is reached where electrons are either torn away or caught up in recombination. The energy of the interior of the star is transported to the outside through an endless process of alternate absorption and emission of radiation. The third point in Eddington's interpretation was the production of energy in the interior of the star, which maintains the outward flow of energy from the centre.

George Darwin

Horace Lamb

Eddington's theoretical investigations demonstrated that energy radiated outward by a spherical layer of a star must equate the energy produced in the interior of the star. But then one must know where this energy is produced, by what matter and under what conditions. In Eddington's time nothing was known about these things. Eddington went ahead by assuming two extreme suppositions—energy is produced uniformly throughout the entire mass, or it is produced in the centre only. Eddington found that results obtained by the two extreme suppositions did not differ significantly. Einstein's principle of relativity indicated a possible source of newly-generated energy. Einstein showed by his famous equation $E = mc^2$, that mass and energy were equivalent. This meant that 1 g of mass was equivalent to $9'10^{20}$ ergs of energy. So one could assume that new energy production in a radiating star would be possible by annihilating mass and in this process the mass of the star would gradually decrease.

Eddington in his classic work *Internal Constitution of Stars* put forward two possible mechanisms for production of energy. One, could be direct annihilation of matter by the coalescence and mutual destruction of two oppositely charged particles namely proton and electron where charges would disappear and mass would be transformed into high-frequency radiation. The other could be transformation of hydrogen into helium. When four hydrogen nuclei and two electrons combine to form an atom of helium some amount of mass is lost and which is converted into energy. Now the question was which one of these two processes actually took place. This question was later answered by German-born American physicist Hans Albrecht Bethe (1906-2005), who observed that stellar energy production resulted from the fusion of four hydrogen atoms. It is not a direct fusion but it happens through the so-called carbon-nitrogen cycle, a cycle of six consecutive nuclear reactions that lead to the formation of a helium nucleus from four protons.

From Eddington's work on the internal constitution of stars emerged the mass-luminosity relationship, according to which the luminosity of a star is entirely determined by its mass. Earlier, while enumerating masses of binary stars, astronomers had observed that stars of similar mass but of different spectral class had almost the same luminosity. It was thought to be causal coincidence. But Eddington

Karl Schwarzschild

showed the relationship is of general applicability.

Eddington was an enthusiastic supporter of the idea of an expanding universe. But he did not believe that an expanding universe would require a beginning, which is now part of the accepted theory of the origin of universe known as Big Bang theory. For Eddington such idea was "too unaesthetically abrupt."

During the last 20 years of his life Eddington mostly worked on a problem what he called "fundamental theory" for unifying the quantum theory, relativity and gravitation. He proposed that the fundamental constants of science, such as the mass of the proton and charge of the electron were a natural and complete specification for constructing a universe. Eddington did not succeed in his attempt. His book entitled *Fundamental Theory* was published posthumously in 1948. His ideas were later abandoned by scientists.

Eddington wrote a number of books which included: *Stellar Movements and the Structure of the Universe* (1914), *Space, Time and Gravitation: An Outline of the General Theory of Relativity* (1918), *The Mathematical Theory of Relativity* (1923), *Stars and Atoms* (1926), *The Internal Constitution of Stars* (1926), *Science and the Unseen World* (1929), *The Expanding Universe : Astronomy's Great Debate, 1900-1931* (1930), *Why I Believe in God: Science and Religion as Scientist Sees It* (1930), *New Pathways in Science* (1935), *Relativity Theory of Protons and Electrons* (1936), *Philosophy of Physical Science* (1939), *The Domain of Physical Science* (1925), and *Fundamental Theory* (1948).

Eddington received a number of awards including the Smith's Prize (1907), Bruce Medal of Astronomical Society of the Pacific (1924), Henry Draper Medal (1924), the Gold Medal of the Royal Astronomical Society (1924), and Royal Medal of the Royal Society (1928). He was knighted in 1930. He received the Order of Merit in 1938. He was the President of the Royal Astronomical Society from 1921 to 1923). He was Fellow of the Royal Society of London, the Royal Society of Edinburgh, the Royal Irish Academy, the National Academy of Sciences, the Russian Academy of Sciences, the Prussian Academy of Sciences and many others. A crater on the Moon and an asteroid (asteroid 2761) are named after him. In the film 'Einstein and Eddington', jointly produced by BBC and HBO, Eddington was portrayed by actor David Tennant.

Edouard Abbe Lemaitre

Eddington died on 22 November 1944 in Cambridge, England. At the time of his death he was the President of the International Astronomical Union.

In 1947, the Royal Astronomical Society of London instituted the Eddington Medal to be awarded for outstanding work on theoretical astronomy. Its first recipient was Belgian astronomer and cosmologist Georges Edouard Abbe Lemaitre (1894-1966), the originator of the idea of 'Big Bang' theory for the origin of the universe. Lemaitre was awarded the Medal in 1953.

Some of the books written on Eddington are: *Eddington: The Most Distiguished Astrophysicist of His Time* by S. Chandrasekhar (Cambridge, 1983); *The Source of Eddington's Philosophy* by H. Dingle (Cambridge, 1954); *The Life of Sir Arthur Stanley Eddington* by A. V. Douglas (Edinburgh-New York, 1956); *Sir Arthur Eddington: Man of Science and Mystic* by L. P. Jacks (Cambridge, 1948); *Eddington's Search for a Fundamental Theory: A Key to the Universe* by C. W. Kilmister (Cambridge, 1994); *Sir Arthur Eddington* by C. W. Kilmister (Oxford, 1966); *Reflections on Philosophy of Sir Arthur Eddington* by A. D. Ritchie (Cambridge, 1948); *From Euclid to Eddington: A Study of Conceptions of the External World* by E. T. Whittaker (1949) and *Philosophy of Science of A. S. Eddington* by J. W. Yolton (The Hague, 1960).

References

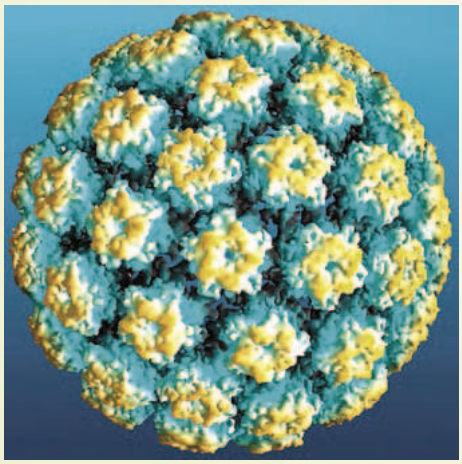
1. Heilbron, J. L., (ed.), *The Oxford Companion to the History of Modern Science*, Oxford: Oxford University Press, 2003.
2. Pannekoek, A., *A History of Astronomy*, New York: Dover Publications, Inc, 1989.
3. Spangenburg, Ray and Diane K. Moser, *The History of Science: From 1895 to 1945*, Hyderabad: Universities Press (India) Limited, 1999.
4. Millar, David et al, *The Cambridge Dictionary of Scientists*, Cambridge: Cambridge University Press, 2002.
5. Ridpath, Ian, *Dictionary of Astronomy*, Oxford: Oxford University Press, 1997.
6. Parry, Melanie (ed.), *Chambers Biographical Dictionary*, New York: Chambers Harrap Publishers Ltd, 1997.
7. *A Dictionary of Scientists*, Oxford: Oxford University Press, 1999.
8. Available sources on the Internet.

(The article is a popular presentation of the important points on the life and work of Arthur Stanley Eddington available in the existing literature. The author has given the sources consulted for writing this article. However, the sources on the Internet are numerous and they have not been individually listed. The author is grateful to all those authors whose works have contributed to writing this article).

Taming killer viruses

□ Biman Basu
Email: bimanbasu@gmail.com

Cervical cancer and AIDS (acquired immunodeficiency syndrome) are two major killer diseases that take a heavy toll of human life every year. And both are caused by viruses – infective agents that typically consist of a nucleic acid molecule in a protein coat and are too small to be seen under a microscope. Today we know that cervical cancer is caused by the human papilloma virus (HPV), and that the human immunodeficiency virus (HIV) causes AIDS. It took years of hard work for three scientists to establish the link between viruses and the two killer diseases – achievements that brought them the Nobel Prize in Physiology or Medicine for 2008.



The illustration shows a view of the molecular surface of the human papilloma virus [Image: Courtesy of the Harrison Laboratory]

HPV

Cervical cancer is the second most common cancer among women and is the primary cause of cancer-related deaths in developing countries. Every year cervical cancer is diagnosed in about 500,000 women globally and is responsible for more than 280,000 deaths annually. In India, cervical cancer is the most common cancer of women, followed by breast cancer. For a long time cervical cancer was believed to be caused by the herpes simplex virus, a virus known to cause a wide variety of infections in humans. But in the 1970s, Harald zur Hausen of German Cancer Research Centre, Heidelberg, Germany, suggested that the causative factor could be another common virus known as human papilloma virus (HPV) that was known to infect the skin and mucous membranes of humans. But his suggestion was not taken seriously at that time because it went against the general opinion linking cervical cancer to the herpes simplex virus.

But Harald zur Hausen was convinced that HPV could be a potential factor in cervical cancer. He assumed that if the tumour cells contained a tumour-causing virus, then they should also contain viral DNA integrated into their genomes. And if that is indeed the case, the HPV genes that promote cell proliferation should be detectable by specifically searching tumour cells for such viral DNA. His realisation that subtypes of a virus that produces harmless warts can also lead to cervical cancer, took a decade of work to prove. By the early 1980s his team found novel viruses in genital warts. Their subsequent identification of two novel HPV subtypes, known as HPV types 16 and 18, in cervical cancers formed the essential piece of evidence linking HPV infection to the onset of the disease. HPV types 16 and 18 were consistently found in about 70% of cervical cancer biopsies throughout the world.

Harald zur Hausen

According to current estimates, more than 5% of all cancers worldwide are caused by persistent infection with the HPV. Infection by the human papilloma virus is the most common sexually transmitted agent, afflicting 50-80% of the population. Of the more than 100 HPV types known, about 40 infect the genital tract, and 15 of these put women at high risk for cervical cancer.

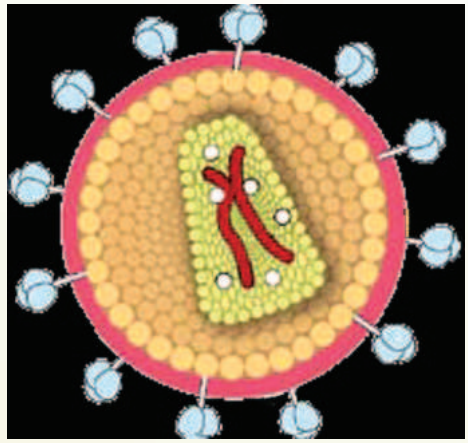
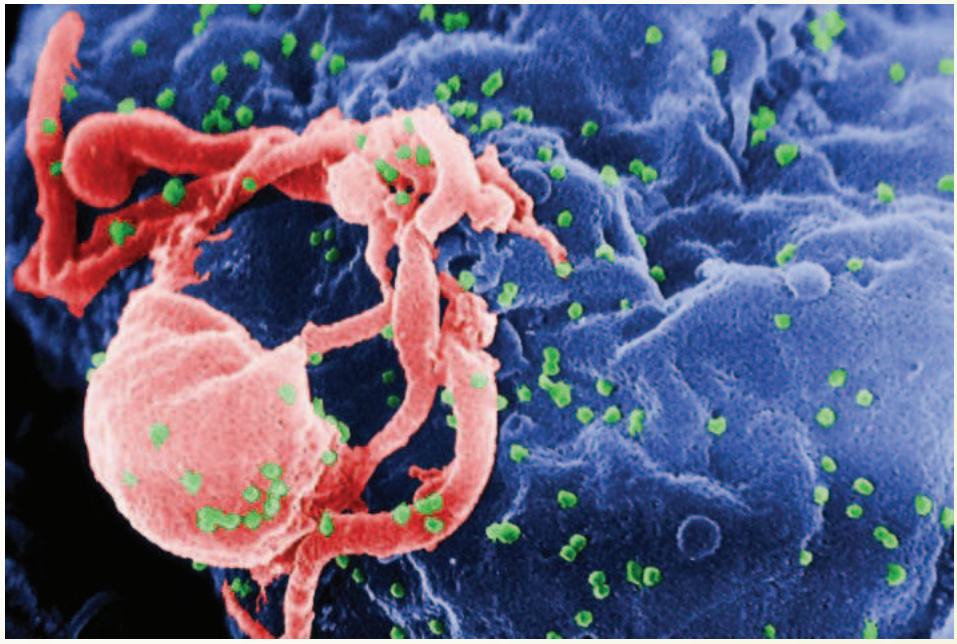


Diagram of the human immunodeficiency virus

Harald zur Hausen's demonstration of the novel properties of HPV have led to an understanding of mechanisms for papilloma virus-induced initiation of cancer formation that has helped in developing vaccines against cervical cancer. Vaccines were ultimately developed that provide more than 95% protection from infection by the high risk HPV16 and 18 types. The vaccines may also reduce the need for surgery. For his work that led to the identification of HPV as the causative agent for cervical cancer, Harald zur Hausen was awarded half of the Nobel Prize in Physiology or Medicine for 2008.



Scanning electron micrograph of HIV (green dots) budding from cultured lymphocyte [Image: Centers for Disease Control and Prevention]

HIV

Soon after the earliest reports of a novel immunodeficiency syndrome first appeared in medical literature in 1981, the search for a causative agent was on. Two French scientists, Françoise Barré-Sinoussi of Virology Department, Institut Pasteur Paris, and Luc Montagnier of World Foundation for AIDS Research and Prevention, Paris, isolated and cultured lymph node cells from patients that had swollen lymph nodes characteristic of the early stage of acquired immune deficiency syndrome, commonly known as AIDS, and detected activity of the enzyme reverse transcriptase, a direct sign of replication of a retrovirus. (Retroviruses are any of a group of RNA viruses which insert a DNA copy of their genome into the host cell in order to replicate.) The researchers also found retroviral particles separating from the infected cells. Isolated virus particles infected and killed lymphocytes (small white blood cells found in lymph) from both diseased and healthy donors, and reacted with antibodies from infected patients. The surprising observation was that unlike retroviruses that cause cancer, the newly discovered retrovirus, now known as human immunodeficiency virus (HIV), did not produce uncontrolled cell growth (tumour). By 1984, Barré-Sinoussi and Montagnier had obtained several isolates of the novel human retrovirus, which they identified as a lentivirus (any of a group of retroviruses producing illnesses characterised by a delay in the onset of symptoms after infection), from sexually infected individuals, haemophiliacs, mother to infant transmissions and patients who had taken blood transfusions.

Francoise Barre-Sinoussi

Luc Montagnier

Soon after the discovery of the virus, several groups contributed to the definitive demonstration of HIV as the cause of acquired human immunodeficiency syndrome (AIDS). Further work by the two scientists allowed identification of important details in the replication cycle of HIV and how the virus interacts with its host. Furthermore, it led to development of methods to diagnose infected patients and to screen blood products, which has helped in limiting the spread of the pandemic. The unprecedented development of several classes of new antiviral drugs is also a result of knowledge of the details of the viral replication cycle. The combination of prevention and treatment has substantially decreased spread of the disease and dramatically increased life expectancy among treated patients.

Never before has science and medicine been so quick to discover, identify the origin and provide treatment for a new disease entity. Successful antiretroviral therapy developed as a consequence of the new findings have made life expectancies for persons with HIV infection reaching levels similar to those of uninfected people. In recognition of their valuable contribution to the discovery and unravelling the secrets of HIV, Barré-Sinoussi and Montagnier were jointly awarded half of the Nobel Prize in Physiology or Medicine for 2008.

Tobacco Smoking:

Bodily Effects, Health Risks and How to Stop

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

Tobacco smoke contains hundreds of substances, which are chemically active and are extremely harmful for the human body. While some of the chemicals are toxic, cause cell mutation, and sometimes trigger cancer, others damage the airway and lead to severe breathing disorders.

> All sin tends to be addictive, and the terminal point of addiction is what is called damnation.
>
> -W. H. Auden, *A Certain World*, "Hell"

Body's acute responses to tobacco smoke are multiple and complex. Nicotine, one of the key ingredients in tobacco, brings in a whole lot of changes. There is an acute rise in contractility of the heart muscle, heart rate, coronary blood flow, use of oxygen, and blood pressure. The veins in the periphery get narrowed. The levels of glucose, stress hormone, free fatty acids, anti-diuretic hormone, and endorphins rise in the blood with multiple physiological effects. It also affects the central nervous system and can both stimulate and depress the brain. The carbon monoxide one inhales from tobacco smoke replaces oxygen in the blood cells, robbing the heart, brain and the rest of your body of this life-giving element.

Principal Constituents of Cigarette Smoke

Substance	Ill effects on the human body
Particulate substances	
Tar	Cancer-causing
Poly nuclear aromatic hydrocarbons	Cancer-causing
Nicotine	Stimulator and depressor
Phenol	Co-cancer-causing and irritant
Cresol	Co-cancer-causing and irritant
Beta-napthylamine	Cancer-causing
N-Nitrosonornicotine	Cancer-causing
Benzopyrene	Cancer-causing
Nickel, Arsenic, Polonium 210	Cancer-causing
Indole	Tumour accelerator
Carbazole	Tumour accelerator
Catechol	Co-cancer-causing
Gases	
Carbon monoxide	Weakens the oxygen transport and usage
Hydrocyanic acid	Damages the airway cilia and is irritant
Acetaldehyde	Damages the airway cilia and is irritant
Acrolein	Damages the airway cilia and is irritant
Ammonia	Damages the airway cilia and is irritant
Formaldehyde	Damages the airway cilia and is irritant
Oxides of nitrogen	Damages the airway cilia and is irritant
Nitrosamines	Cancer-causing
Hydrazine	Cancer-causing
Vinyl chloride	Cancer-causing

Cigarette smoke and its condensate contain several cancer-causing substances. These include aromatic hydrocarbons, aromatic amines, and nitrosamines, with catechol, cresol and phenol enhancing their carcinogenic effects. Many constituents of cigarette smoke also act as potent irritants to the lungs, hamper the functioning of cilia, and increase mucous secretion. Smoking also deadens the taste buds and sense of smell, so food may not be as appetizing as it once was.

Long-term Health Risks

Large population studies have found a strong association between tobacco smoking and several diseases. Heart disease, cancer, and lung diseases account for a number of deaths associated with smoking.

Heart disease

Tobacco smoking is a major risk factor in premature coronary heart disease. It acts in tandem with, and enhances other known coronary risk factors, viz., high blood pressure, high cholesterol, diabetes, and a positive family history. It can be a major cause of sudden death in heart attacks. Smokers who undergo bypass surgery have a relatively poorer success rate than non-smokers. The risk of heart disease decreases with cessation of smoking, and benefits appear at the end of the first year itself.

Cerebral Stroke

The risk of brain stroke, just as heart disease also rises in smokers. Large community studies have shown that the risk is dose-dependant and rises with the number of cigarettes one smokes. Among women smokers who use oral pills for contraception, the risk is more severe. They are also vulnerable to haemorrhage.

Blockages of blood vessels

Tobacco smoking presents the most ominous risk factor of blockages in the arteries. These blockages can affect the blood vessels of the legs, and also the abdominal part of the aorta, and can lead to shortfall in blood flow to the legs which may result in gangrene.

Cancers

Tobacco smoking is the cause of nearly 90 per cent of lung cancer cases. Inhaled tobacco smoke, from cigarettes, *bidis*, cigars and pipes, also comes into direct contract with the tissues of the mouth, throat, voice box, and the food pipe. Several studies have found that smokers are four to five times more likely to develop oral and laryngeal cancer than are non-smokers. The risk of oral, laryngeal and oesophageal cancer is also high in those who chew or inhale tobacco. Studies have also linked smoking with the development of cancer in distant organs—that is, in organs not directly exposed to the smoke, such as the bladder, kidney, pancreas, stomach, and uterus.

Lung diseases

Smoking is a major cause of chronic bronchitis, emphysema, and other respiratory diseases. There is loss of protective ciliary action, chronic narrowing and clogging of the airway passages in the lung with increase in mucous secretion. This causes permanent damage and leads to chronic cough, sputum production, and breathlessness. The body is starved of oxygen and may develop respiratory failure.

Smokers are also at increased risk of developing respiratory infections, pneumonia and colds. They have an increased vulnerability to lung complications following any major surgery.

Pregnancy

Smoking may delay conception. It also affects the baby adversely during pregnancy. Infants, whose mothers smoke during pregnancy weigh, on an average, 170 g less than infants whose mothers do not smoke. Mothers who smoke during pregnancy also run higher than normal risk of miscarriage, foetal deaths, and their babies may also die soon after the birth.

Gastric and duodenal ulcers

Chewing and smoking tobacco increases the tendency to acid reflux and heartburn, worsens peptic ulcers in the stomach and duodenum, and increases the relapse rates of ulcers.

Dangers of Second-hand Smoke

There has been considerable research focusing on the effects of second-hand tobacco smoke. Non-smokers, who share the same indoor environment as smokers, must involuntarily inhale the side-stream tobacco smoke. The side-stream smoke contains greater concentrations of many smoke constituents than does main-stream smoke, but since it gets diluted in a large volume of air, the smoke exposure is less than that associated with smoking. Still, it is a major cause of air-pollution and a major health threat to the non-smokers. The exposure can lead to lung cancer and heart disease, and worsen respiratory conditions such as asthma, pneumonia, and bronchitis.

Children who are exposed to smoke have a higher frequency of respiratory illness than children of parents who do not smoke. Second-hand smoke increases the risk of getting ear infections, pneumonia, bronchitis or tonsillitis in children. As a result, many countries including India

have enacted laws limiting smoking in public places. There is a need to strictly enforce these laws so that non-smokers do not have to pay a price for what others do.

Types of Smoking

Smokers often believe that the use of better filter-tipped cigarettes and low-tar and low-nicotine cigarettes lowers the risk. They must know that compared with not smoking or quitting, the benefits are minimal. People who choose low-tar and low-nicotine cigarettes generally inhale more frequently or deeply and may actually increase their exposure to harmful substances.

Cigar and pipe smoke contains the same toxic and carcinogenic compounds found in cigarette smoke. The smoke exposure of pipe and cigar smokers may be significantly less, but mortality rates from cancer of the mouth, throat, larynx, pharynx, and food pipe are about equal whether one smokes cigarettes, cigars, or pipe. The rates of coronary heart disease, lung cancer, emphysema, and chronic bronchitis for cigar and pipe smokers relate to the amount of smoking and the degree of inhalation. In those who inhale consistently, the adverse effects are comparable to those of cigarette smokers.

How to Stop Smoking

Around the world more than 400 million people have QUIT smoking and reduced the risk tremendously; 95 per cent of them succeeded without taking any formal help. Studies have found that 10 or more years after stopping, the death rate among those who smoked 20 cigarettes or less a day was about the same as that among non-smokers. If you mull over it is easy to determine the gains.

Stop now

Once you have made a decision to stop, you are half way there. Throw out all your cigarettes, lighters, matches, and ashtrays. Tell your spouse, friends, and co-workers of your intention so that they

can provide support through trying times. Now, get through without smoking for a day, then another, and then another. Eventually it begins to get easier and you begin to enjoy the benefits of not smoking.

Be motivated

The key to stopping is commitment. Smokers strongly motivated to stop were found twice as successful as those who were less motivated. List your reasons for stopping. Tell yourself life is too beautiful to be squandered on this vile habit.

Draw a coping plan

Once you have decided to stop smoking, pay attention to your behaviour. List your key triggers to smoking, like when, where, and with whom did you usually smoke? Draw a plan to cope with these situations when you stop. Never let your self be persuaded to smoke 'that one last time'.

Take steps to relax

Find other positive ways of relaxing. Take deep breaths, enjoy a shower, go for a walk, run, swim, but do not think about the vile stick. If you were in the habit of holding or playing with the cigarette, find a replacement. You may doodle, play with a bunch of keys, or twiddle your thumbs.

Divert your mind

Whenever you feel a need to smoke, do something else. It does not matter what. Drink a glass of water, eat an apple, speak to a friend, do anything, but whatever you do, do not sit still and think about how much you want to smoke.

Seek help

If you are one of those die hard tobacco addicts, do not hesitate to take formal help. Talk to a physician. He or she can help by counselling you, writing an anxiety-relieving medication for you, and reinforcing your resolve.

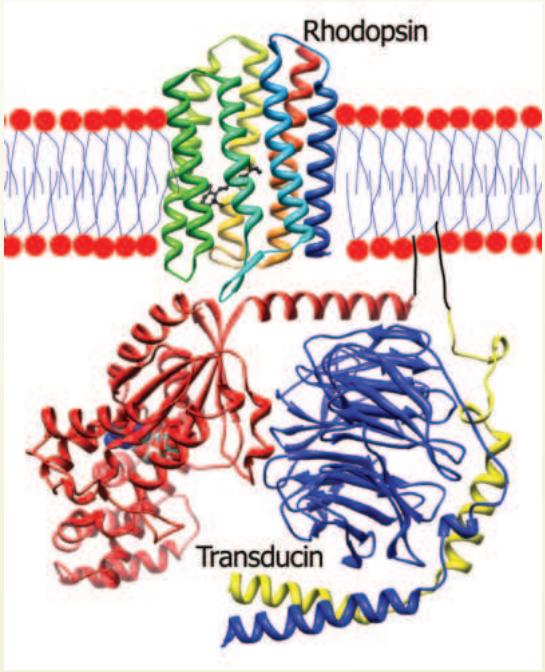
If you are convinced about stopping, but find the going too rough, you could try aversive therapy, acupuncture, or nicotine replacement therapy. The last one delivers nicotine to the brain and thus helps relieve symptoms of nicotine withdrawal when you stop lighting up. You get 'nicotine patches' that deliver the nicotine through your skin into your bloodstream; 'nicotine gum', which is a gum-like resin and delivers nicotine to the blood through the lining of your mouth; and 'nicotine nasal spray' available on prescription and sprayed directly into nostrils. ■

Recent Developments in Science and Technology

☐ Biman Basu
Email: bimanbasu@gmail.com

New light on chemistry of vision

It has been known for more than two centuries that seeing involves chemical changes in the retina of our eye when light falls on it. The retina contains two types of cells called rods and cones. The rods, which are more numerous and more sensitive to light than cones, contain a pigment called rhodopsin, which absorbs the light falling on it and triggers a chain of chemical reactions that ultimately make us see. But, till recently, the exact changes that occur when light falls on rhodopsin were not known. Now a team of researchers from the United States and Switzerland have shed new light on this process by isolating the intermediate complex involved in this chemical communication. The researchers discovered that transitory binding between photoactivated rhodopsin and a protein called transducin is the first step in the chain of reactions that ultimately makes the eye 'see'. Changes brought about by light in rhodopsin allow transducin to dock onto the photoactivated rhodopsin surface. The researchers could isolate and characterise a stable complex between photoactivated rhodopsin and a protein called transducin that is naturally expressed in vertebrate retina rods and cones (*The FASEB Journal*, February 2009). This exciting new work shows how light becomes a chemical signal to the brain.



Rhodopsin-Transducin complex
[Image: Dpryan]

Transducin belongs to a class of proteins called 'G proteins', short for 'guanine nucleotide-binding proteins', which are a family of proteins involved in transmission of messages within cells. G proteins function as 'molecular switches,' alternating between an inactive guanosine diphosphate (GDP) and active guanosine triphosphate (GTP) bound state, ultimately going on to regulate downstream cell processes.

To make their discovery, the researchers isolated rhodopsin/transducin directly from retinas taken from cattle eyes, suspended them in solution, and exposed them to light to start the chemical signalling process. After light exposure, any contaminating proteins were removed, and the remaining combination of rhodopsin and transducin was removed using a centrifuge.

According to Krzysztof Palczewski, senior author of the paper, the results may have important implications for discovery and development of more specific medicines to treat transducin-linked dysfunction and disease. Examples of health problems involving abnormal functioning of transducin include blindness, diabetes, allergies, depression, cardiovascular defects and some forms of cancer. So, in addition to helping scientists understand how vision begins, this research may also help in treating disorders affecting heart beat, blood pressure, memory, pain sensation, and infection response because it is believed that they are regulated by similar chemical communications involving similar proteins.

Fighting malaria by starving the parasite

Malaria is a disease caused by a parasite *Plasmodium* and is one of the world's biggest killers today. Hundreds of millions of people are infected and more than a million people are killed every year – many of them children under five. Among the commonly used antimalarial drugs are chloroquine, mefloquine, primaquine, pyrimethamine, and quinine. Other drugs are constantly being developed. However, in recent years, some strains of *Plasmodium* have become resistant to antimalarial drugs, and there is a constant need to identify and validate new antimalarial target molecules. Recently, a team of scientists from the Monash University in Melbourne, Australia, claim to have discovered an effective treatment for malaria that could lead to new and more effective drugs.

The scientists, based at Australian Research Council Center of Excellence in Structural and Functional Microbial

Blood cells destroyed by Plasmodium falciparum *(centre)*

Genomics in Monash University, have identified chemical compounds which effectively 'switch off' the parasite's digestion, leading to its death inside malaria infected mice in a few days. By inhibiting its digestive machinery the parasite is deprived of any sustenance; as a result it starves and dies (*Proceedings of the National Academy of Science*, Early edition, doi/10.1073/pnas.0807398106).

Malaria is caused by four species of parasitic protozoa that infect human red blood cells. Protozoa are one-celled organisms that are as sophisticated as a human cell. Malaria parasites feed on red blood cells for a living but *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium malariae*, *Plasmodium ovale* malaria parasites have a complex life cycle. In order to live, they need to have both a human and a mosquito host.

When a mosquito carrying malaria parasites from an infected person bites a healthy person it transfers the malaria parasite into the latter's blood stream. The parasites then travel through the bloodstream to the liver where they multiply. This is then followed by headaches, nausea and vomiting. If left untreated, it will disrupt the blood supply to vital organs and can even cause death.

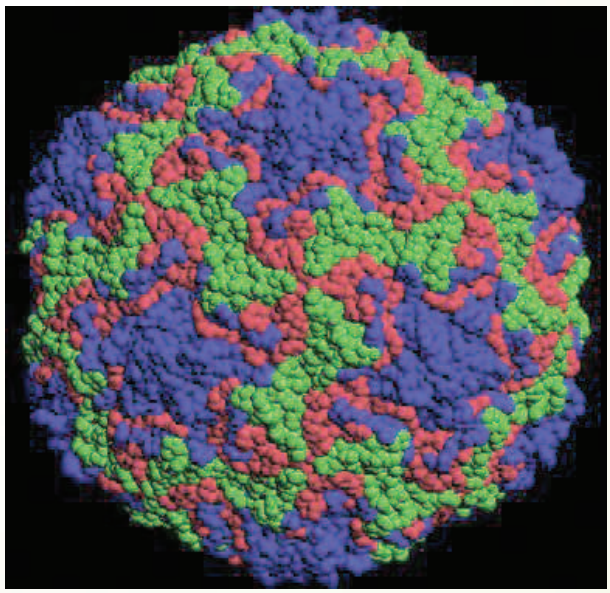
But, for effective transmission of the disease, the malaria parasite has to break down proteins of the blood cells in order to obtain nutrients, which it carries out inside a specialised compartment called the digestive vacuole in its body. To break down blood protein the parasite needs an enzyme – an aminopeptidase known as PfA-M1, which is found outside the parasite's digestive vacuole. The researchers found that bestatin, an antibiotic originally isolated from filtrates of the fungus *Streptomyces olivoretticul*, prevents *P. falciparum* growth in culture. Another compound, hPheP[CH_2]Phe (termed as 'compound 4', or Co4), was found to reduce infection of *Plasmodium* in mice substantially.

From the X-ray analysis of the structure of the enzyme PfA-M1 the researchers were able to understand the inhibitory action of bestatin and Co4; both the compounds bound to the active site of PfA-M1 thus blocking it and made the enzyme inactive, which in turn prevented it from breaking down blood protein. The researchers are hopeful that the new discovery could lead to new and more effective drugs to fight the deadly disease in the near future.

The common cold virus decoded

The common cold is a highly contagious, viral infectious disease of the upper respiratory system. It is caused by a class of viruses called rhinoviruses. Apart from the common cold, the human rhinovirus is believed to cause half of all asthma attacks and is a factor in bronchitis, sinusitis, middle ear infections and pneumonia. Scientists have recently cracked the genetic code of all the strains of the virus that causes the common cold, paving way for better cure for the disease.

Although the common cold is generally mild and self-limiting, patients with common colds often miss school or work days and the annual cumulative societal cost of the disease in terms of money spent on remedies and hours of lost productivity is substantial. Also, recent studies indicate that early rhinovirus infection in children can program their immune system to develop asthma by adolescence. At present there are no antiviral drugs approved to treat or cure rhinovirus infection; all medications used are palliative and treat symptoms only. Recently, a team of scientists at the University of Maryland School of Medicine and the University of Wisconsin, Madison, USA have put together the genome sequences of all known strains of human rhinovirus responsible for the common cold, an accomplishment that might help in designing antiviral agents and vaccines, eventually leading to the first cure for the illness (*Science*, 12 February 2009, 10.1126/science.1165557). The researchers led by biochemist and virologist Ann C. Palmenberg of the University of Wisconsin, Madison have also assembled the genome data into a "family tree" showing their relationships. The family tree shows that some regions of the rhinovirus genome are changing all the time but there are others that never change.



False-colour X-ray image of human Rhinovirus14 [Image courtesy of Dr. Jean-Yves Sgro, University of Wisconsin-Madison]

Analysis of the data base showed that some human rhinoviruses result from the exchange of genetic material between different strains of the virus in one person. The viruses also mutate often, helping them avoid being hunted down by the immune system. The researchers found that human rhinoviruses are organised into about 15 small groups that come from distant ancestors. According to the researchers the discovery of these multiple groups explains why no single antiviral drug is effective against the common cold. Possibly, several antiviral drugs, targeted to specific genetic regions of certain groups, would be needed.

Before the present study, the genomes of only a few dozen rhinoviruses had been sequenced from a frozen collection of 99 different rhinovirus strains taken from patients over more than two decades. The study by Palmenberg and colleagues adds 80 genome sequences to this "library" and 10 more acquired recently from people with colds. During the study, several other research groups began to report the full genomes of some of the viruses in the previous collection, as well as some odd rhinovirus-like strains.

The researchers are hopeful that the genome data base can help them put together many pieces of the human rhinovirus puzzle to help us answer some fundamental questions about rhinoviruses, like how these rhinoviruses might mutate as they spread from one person to another; which rhinoviruses are more associated with asthma exacerbations; and why rhinovirus exposure in infancy may cause asthma later in life. With all this information at hand there is also hope for the development of the long-sought cure for the common cold.

Imposter caterpillar

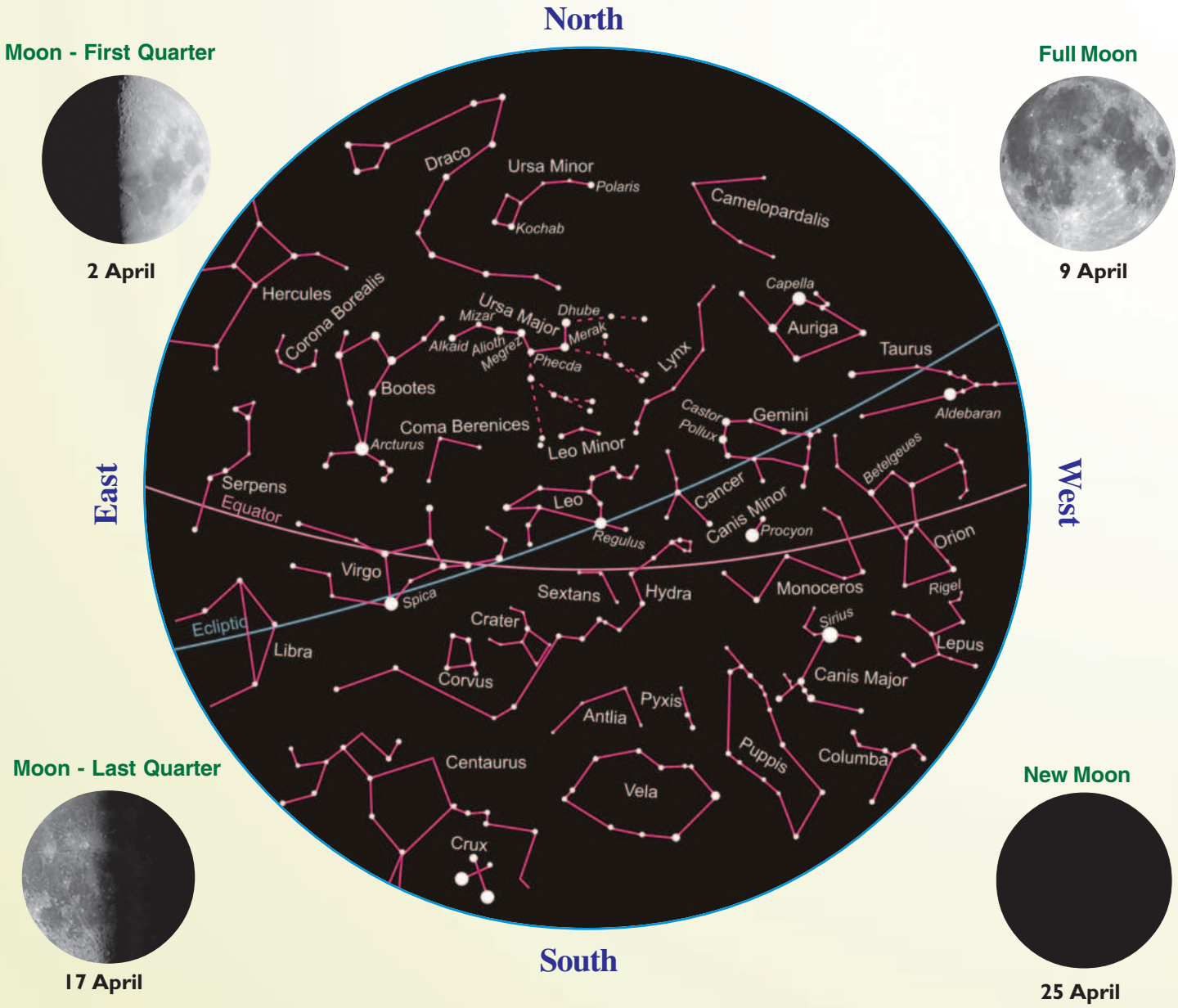
Mimicking voice is an art many performers are adept in. There are many individuals who are known to mimic the voice of well-known movie actors. Interestingly, such deception is found in the animal world too, as a recent paper in the journal *Science* shows.

Ants are known to communicate using chemical signals. But they also use a kind of faint chirping noise, which they produce by rubbing their legs against grooved lower abdomen. Although we cannot hear it, the chirping sounds allow one kind of ant to distinguish between workers and queens. Entomologist Jeremy Thomas of the University of Oxford, UK, and his team of British researchers have even recorded the sounds produced by worker ants and the queen of the species *Myrmica schenki*. Acoustic analysis of the recorded sounds revealed that worker chirps differed from the chirps of queens (*Science*, 6 February 2009). When the researchers played recordings of queen ants on tiny speakers, workers became more attentive to the queens' sounds, gathering and sometimes standing guard around the speaker.

A more surprising discovery of the British team was the mimicking of the sound made by queen ants of the species *M. Schenki* by the caterpillars of the parasitic butterfly *Maculinea rebeli*. The caterpillar mimicked the sounds of the queens more closely than those of workers. This makes the caterpillars welcome guests in the ant colony, enabling them to achieve high status within ant societies. Thomas and colleagues found that sound mimicry was the key. Once the caterpillar got inside, it is cared for like a queen. According to the researchers, it is the first time this type of mimicry has been found in any species of social parasite. ■

Caterpillar of Maculinea rebeli *getting royal treatment in* Myrmica schenki *ant colony*

Sky Map for April 2009



The sky map is prepared for viewers in Nagpur (21.090 N, 79.090 E). It includes constellations and bright stars. For viewers south of Nagpur, constellations of the southern sky will appear higher up in the sky , and those of the northern sky will appear nearer the northen horizon. Similarly, for viewer north of Nagpur, constellations of northern sky will appear higher up in the sky, and those of the southern sky will appear nearer the southern horizon. The map can be used at 10 PM on 1 April, at 9 PM on 15 April and at 8 PM on 30 April.

Tips to use sky map:

(1) Choose a place away from city lights/street lights. (2) Hold the sky-map overhead with North in the direction of Polaris. (3) Use a pencil torch for reading the sky map. (4) Try to identify constellation as shown in the map one by one.

Visibility of Planets⁺ (IST)

	Rising	Setting	In the Zodiac
Mercury	06:42	19:41	Pisces-Aries-Taurus
Venus	04:21	16:37	Pisces
Mars	04:23	16:17	Aquarius- Pisces
Jupiter	02:38	13:55	Capricorns
Saturn	15:35	04:06	Leo
Uranus*	04:23	16:17	Pisces
Neptune*	02:52	14:14	Capricorns

⁺Time shown is subject to vary (± 1 hr) from place to place.
*Not naked eye object

Sky Event

Date	IST	Event
02	08:01	Moon at perigee
16	14:45	Moon at apogee
19	03:00	Moon-Jupiter
22	19:44	Moon-Venus
24	21:50	Venus-Mars
26	13:29	Mercury at greatest elongation (E)
26	22:00	Moon-Mercury
28	11:56	Moon at perigee

□ **Arvind C. Ranade**
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Astronomy

Editorial (Contd. from page 35)

in the novel method of gravitational microlensing, the use is made of the fact that when a planet happens to pass in front of a distant star along our line of sight, the planet's gravity will behave like a lens, bending the light coming from the distant star. This *lensing* effect focusses the light rays and causes a temporary sharp increase in brightness and change of the apparent position of the distant star. Direct imaging of the planet, however, is a difficult proposition at present, but may become possible in the days to come.

If our goal is to find planets with evidence of life, those discovered so far certainly do not make good candidates. Many of them get too hot or too cold and hence cannot support life. Many have highly elliptical orbits, or are too close to the parent stars. For example, the right location, or the *habitable zone*, in our solar system would be between Venus and Mars. How shall we know if a planet could support life? First, we must look for the signs of liquid water. Next, we must look for the evidence of oxygen, especially ozone (O_3) produced by plants and algae, and the signs of biological activity in the form of methane (CH_4), which is produced by living organisms. Further, we shall need to analyse the reflected light from the planet to see if the planet has an atmosphere.

Clues for alien Earths; that is, small, rocky planets orbiting at the right distance to be not so hot that water boils and not so cold that it stays frozen, have been hard to come by. This is so because surveys have not been sensitive enough to find many such planets. This should change with the *Kepler Space Telescope* launched by NASA on 7 March 2009. Its unique positioning in the solar system and unprecedented sensitivity imply that for the first time we will be able to see Earth-sized planets in the habitable zone of their stars, that is, the region where the temperature on the planet should be right for liquid water to exist at its surface.

Indeed, the vast majority of exoplanets were discovered by the radial velocity technique which is not sensitive enough to detect planets as small as the Earth. However, *Kepler* will use the method of planet transits - a far more reliable method. By monitoring more than 1,00,000 stars for periodic dips in brightness, it would spot when a planet passes in front of them. *Kepler* would be in its own orbit around the Sun far away from the Earth's orbit, and hence the Earth would not cause any interference with observations. The most important aspect is the fact that *Kepler* would observe the same part of the sky uninterrupted for the entire mission of about three-and-a-half years. *Kepler* would observe at least three transits of any planets it finds that are in one-year orbits, like Earth's. This is necessary for confirming the recurrence of transit events at a precise interval, thereby ruling out undesirable factors such as fluctuations in the brightness of the star itself. Further, *Kepler* will also be much more sensitive than *CoRoT*. It will have an effective light-gathering aperture of 95 centimetres, compared with *CoRoT*'s 27 centimetres, which should allow it to see planets as small as half the size of the Earth, or about the width of Mars.

How many Earth-sized planets will *Kepler* find? No one knows! But, whatever *Kepler* discovers, would certainly guide the next stage of planet-hunting. If Earth-like planets are common, then at least a few may be orbiting stars near enough. If so, future missions could scrutinise them for evidence of oxygen and other clues that could hint at the presence of life. Incidentally, NASA and ESA have been working on missions called *Terrestrial Planet Finder* and *Darwin*, respectively. These missions aim to observe the faint glimmer from exoplanets in the habitable zone of their stars, and look for signatures that would hint at the presence of life. There is no gainsaying the fact that the success of these missions rests on the *Kepler* Mission. But if *Kepler* finds that rocky planets in the habitable zone are rare, then there may not be many planets close to us to observe in detail.

Earlier our planet was believed to be at the centre of the universe. Copernicus displaced it, and ever since, our place in the cosmos has steadily become less and less privileged! Earth was just one planet out of many. "Now we are also seeing that our solar system is not necessarily particularly special; we know of hundreds of planets around other stars", says Jonathan Lunine of the University of Arizona, Tucson, who chaired a committee called the Exoplanet Task Force that produced a report last year on alien worlds.

Is anybody out there?

□ Vinay B. Kamble

Letters to the Editor

Masterly and authoritative editorials

I have gone through all the editorials in *Dream 2047*. They are masterly and authoritatively written. I also enjoyed your contributions entitled Jacobus Henricus van't Hoff and Christiaan Huygens. Excellent! Your narrations are smooth and tidy. They make an enjoyable reading. Biman Basu's articles are also well written and and quite readable accounts of historical and current developments in science. My hearty congratulations! Keep up the very good work you are doing.

Baldev Raj Dawar
baldevraj.dawar@gmail.com

Your editorial on Darwin (*Dream 2047* February) was excellent. It covers very well the contribution of this great scientist (I consider him the greatest so far) who changed forever the concept of man, god, etc., in all religions. It was perhaps biggest leap towards rationality which we especially in India need most. This editorial should be published in more journals. Best wishes to you and your entire team.

P.P. Sharma,
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Rail Bhawan, Ministry of Railways
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Informative magazine

I am a graduate student from a remote village of Assam. Recently I came to know about Vigyan Prasar publication *Dream 2047* and found it very informative. We have a small library in our village which is frequented by students and also general public. It would be very kind of you if you send copies of this valuable publication to our library regularly. This will enrich the knowledge of the students and general people.

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Prof. B. L. Saraf

Professor Babulal Saraf, 85, passed away on 1 March 2009. He was actively involved in physics teaching innovations and has spent his active life with BARC, Mumbai and University of Rajasthan, Jaipur. Even after retirement he has been engaged in spreading the message of science in the country. His creations, known as "SARAF'S Equipment", will remain alive in several universities, colleges and other institutions in the country and abroad.

Born on 2 December 1923 at Badnawar (MP) Saraf got his school education in a nearby town and then did his graduation 1947 and M.Sc. in physics in 1949 from Agra University. He started his research carrier in Delhi University in 1949, where he developed several electronic modules for the study of neutron energy spectrum from Ra-Be source.

During 1952-55, he went to Bartol Research Foundation, Swarthmore, USA, where he studied the inner bremsstrahlung spectra of electron capture decays from various nuclei and their decay schemes. He developed the lens-type beta spectrometer. He also spent some time at the Nobel Institute of Physics in Stockholm, Sweden, to develop automatic relay system for operation of heavy particle spectrometer. He joined Atomic Energy Establishment (now BARC), Trombay, Bombay in 1955. He was awarded Ph.D. degree in 1958 from Agra University on "Inner bremsstrahlung spectra of electron capture decay". He served AEE till 1965 and developed pulse height analyser, multi-channel analyser and other electronic modules for spectroscopy and coincidence measurements.

In 1965, he joined the University of Rajasthan, as Professor of Physics. In ten years' time he established several research facilities, like positron annihilation, Mossbauer spectroscopy, X-ray absorption and thin films along with teaching laboratories in the department of physics.

In 1975 he coordinated the college science improvement program (COSIP) in the state of Rajasthan supported by UGC. In 1977 he established the science education centre (SEC) and university science and instrumentation centre (USIC) in the university. During this time a large number of new laboratory

experiments were developed and included in the laboratory through the University Leadership Program (ULP) of UGC. In 1978, he established a Centre for Development of Physics Education (CDPE) in the University of Rajasthan.

He demonstrated these innovative laboratory equipment at several universities, colleges and institutions in the country and abroad in USA, Oxford University, UK, ICTP, Trieste, Italy, Maidigury University, Nigeria, University of Nairobi, Kenya, and University of Dar-e-salam, Tanzania.

In December 1983 he retired from the University of Rajasthan and joined as professor of emeritus at BHU, Varanasi.

During 1986-88, he directed teachers training program for the African universities on low-cost laboratory equipment design and fabrication. A laboratory and workshop was established at university of Dar-e-salam, Tanzania, supported by UNESCO-UNDP and ICTP Italy, to conduct training program. 100 teachers and technical staff from 40 different universities were trained.

During 1992-1997, he worked for the state of Madhya Pradesh to upgrade the PG laboratory teaching in colleges around Ratlam, with support from the state government, UGC and IUC Indore. In 1998, he joined IPS Academy, Indore. He has established laboratory and workshop facilities to nurture laboratory innovation, with moderate support from the private Indore Public School. The institute has initiated M.Sc. Physics teaching program since 2003 under his guidance. He has published number of papers, articles and popular books like the two-volume *Physics through Experiments*.

In Prof. Saraf, one finds a highly motivated physicist, dedicated to learning through experimentation, who may inspire the young generation. A documentary film "Prof. Babu Lal Saraf: Master Experimentalist", produced jointly by the Inter-University Accelerator Centre, Vigyan Prasar, and University of Rajasthan, was released on 11 July 2007 by Prof. Yash Pal, Chancellor, JNU, New Delhi, and Prof. N K Jain, Vice Chancellor, Rajasthan University.

Novel apparatuses developed by Prof. Babu Lal Saraf include linear air track with magnetic gliders that can quantitatively demonstrate collisions, potentials and oscillations, Torsion wave apparatus that can be used to show reflection, interference and characteristic impedance, driven oscillator system, which can show mechanical resonance and damping, Lissajous figure apparatus with mechanical and optical display, Barton's pendulum to show coupling and energy transfer response, induced EMF apparatus to demonstrate Faraday's law and damping, apparatus to demonstrate conservation of angular momentum, fall of magnet in conducting cylinder and terminal velocity, and torsional oscillator to demonstate internal friction. ■

Dr. Subodh Mahanti, Scientist 'F', Vigyan Prasar received "Aatmaram Puraskar" by Her Excellency President of India Smt. Pratibha Devi Singh Patil in a function at the Rastrapati Bhavan. Dr. Mahanti has also been honoured with the following prizes: NCSTC National Award (2003) for best contribution in science popularization through mass media. FIE Foundation National Award (2000) for quotable contribution in science popularizations; 'Balsahitya Kriti Samman' (2006) by Hindi Academy, Delhi and 'Dr. Meghnad Saha Puraskar' (2005) by the department of science & technology.

YOUR OPINION

Dream 2047 **has been inviting your opinion on a specific topic every month. The reader sending the best comments will receive a popular science book published by VP. Selected comments received will also be published in *Dream 2047*. The comments should be limited to 400 words.**

This month's topic:

Is the current invasion of the electronic media and the Internet in our daily life leading to a decline in our reading habit?

Response should contain full name; postal address with pincode and email ID, if any; and should be accompanied by a recent passport size photograph. Response may be sent by email :(**opinion@vigyanprasar.gov.in**) or by post to the address given below. If sent by post, "**Response: *Dream 2047* April 2009**" should be clearly written on the envolope.

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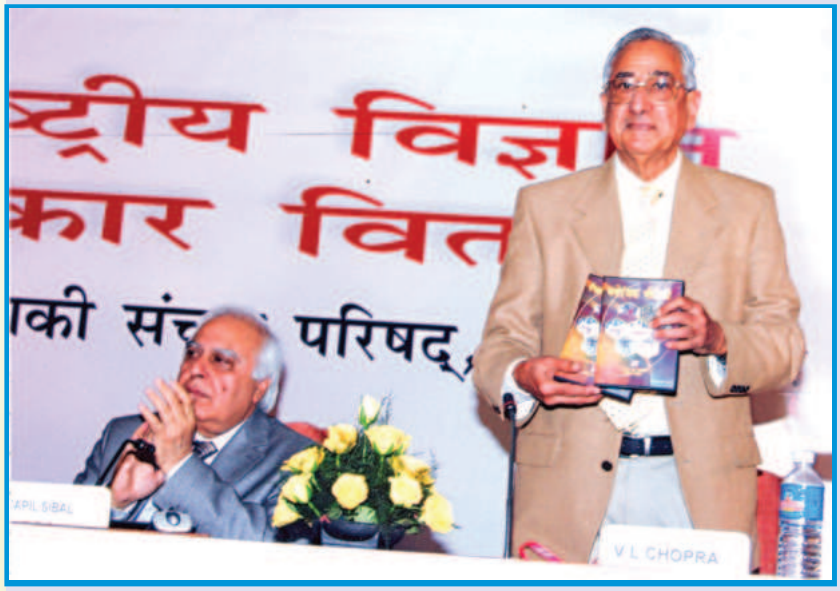
National Science Day 2009 – Release of a CD



Dr. V. L. Chopra releasing the CD on 'Fun with Physics'. Also seen (left) Hon'ble Union Minister for Science & Technology and Earth Sciences Shri Kapil Sibal

An interactive multimedia CD on 'Fun with Physics', brought out by Vigyan Prasar was released by Padma Bhusan Dr. V. L. Chopra, Member (Science, Technology & Environment) Planning Commission, during National Science Day Celebration on 27 February 2009 at Technology Bhawan, New Delhi. Present on the occasion were Hon'ble Union Minister for Science & Technology and Earth Sciences Shri Kapil Sibal and Dr. T. Ramasami, Secretary to the Government of India, Department of Science and Technology.

The CD contains 30 novel experiments/ activities on different concepts of physics along with video clippings of the actual activities. The experiments are suitable for at students and teachers of class VI to X.

The experiments were jointly developed by Department of Physics, Indian Institute of Technology, Kanpur and Vigyan Prasar. A majority of the experiments can be performed using commonly available objects/ equipment. The CD is available both in Hindi and English.