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Monthly Newsletter of Vigyan Prasar

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VP News

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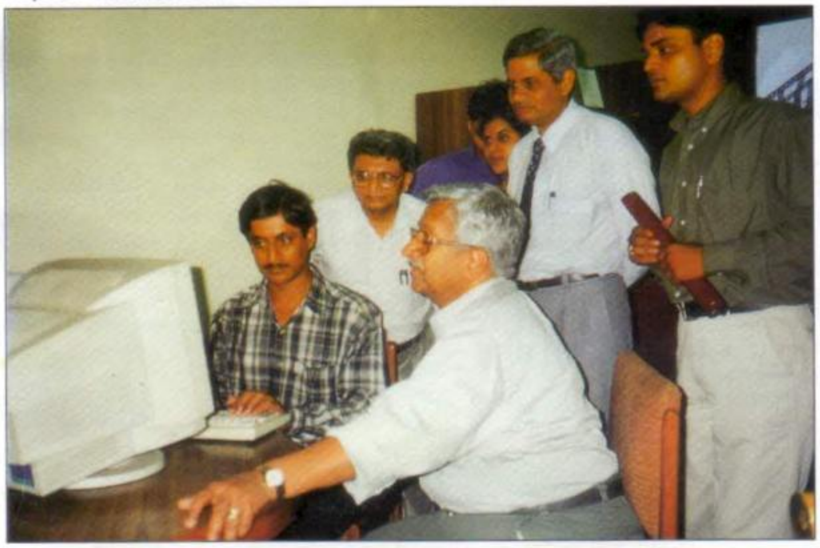
All Motion is Relative

Intellectual Property Rights
(Part-III : International and Regional Agreements)

CHAT SESSIONS

Chat sessions on Vigyan Prasar Homepage www.vigyanprasar.com or www.vigyanprasar.org have turned out to be quite popular since we had the first one on May 26, 2001. The one hour on-line interactive chat session on different S&T topics are, by and large, held every fortnight. On June 06, 2001, the topic of the chat session was "Ham Radio in India". The expert was Shri Sahruddin, President, Amateur Radio Society of India, himself a ham of long standing and one who has contributed a great deal in popularising ham radio in the country. Shri Sahruddin answered some 25 questions on various aspects related to ham radio — from very elementary to those related to policy and technical details.

On July 13, 2001, Prof. V.S. Ramamurthy, Secretary, Department of Science & Technology and Chairman, Governing Body of Vigyan Prasar, answered questions on the theme "Thinking Scientifically". The response was overwhelming. Prof. Ramamurthy answered over 30 questions in one hour. As a matter of fact, due to paucity of time, questions from several participants could not be answered. We have received several questions through e-mail as well, which Professor Ramamurthy will answer later on. It is interesting to note that the participants ranged from the very young to grown-ups and experts in different fields.



Prof. V.S. Ramamurthy replying to the queries during the chat session. Also seen on are Dr. V.B. Kamble (second from left) and Shri Anuj Sinha, Head, NCSTC (fourth from left)

The next chat session would be on August 03, 2001, Friday, 11.00 a.m. and the expert will be Dr. Yatish Aggarwal, Doctor and popular Health Columnist. He was our expert for chat session on June 09, 2001 too. Due to public demand, Vigyan Prasar will be organising one more chat session with Dr. Aggarwal on the topic "Health and Medicine". Please do log on to www.vigyanprasar.com (or www.vigyanprasar.org).

Shri Sahruddin, President, Amateur Radio Society of India

In case, you are unable to access our homepage, you can e-mail you queries in advance or immediately after the session to vigyan@hub.nic.in, www.vigyanprasar.com or www.vigyanprasar.org.

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

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Editor : Dr. V.B. Kamble

Human Development – We still have a long way to go

Human development of a country does not necessarily imply the rise or fall of its national income. It is about creating an environment in which people can develop their full potential and lead productive, creative lives depending on their needs and interests. People are the real wealth of a nation. Development would hence relate to expanding the choices people can have enabling them to lead lives they value. It is much more than economic growth, which though important, is only a means of enlarging people's choices. How does one enlarge these choices? Well, it is through building capabilities – the range of things that people can do or be in life. The most basic capabilities that need to be built are those that would help people lead long and healthy lives, be knowledgeable, have access to resources needed for a decent standard of living, and help them participate in the community life. Obviously, in the absence of these, many choices are just not available, and many opportunities life remain only a distant dream.

The unprecedented gains in the last century in advancing human development and eradicating poverty came largely from technological breakthroughs. In India, over a period of 25 years, i.e., from 1975 to 2000, life expectancy at birth went up from 50 years to 62 years. This became possible through development of medical technology – vaccines and antibiotics. The green revolution helped treble the agricultural production since independence. This was made possible through the technological breakthroughs in plant breeding, fertilisers and pesticides during the sixties. However, there is no gainsaying the fact that development and technology enjoy an uneasy relationship. Quite often, development through a technology comes at a high cost, for example, chemical fertilisers having an adverse effect on the fertility of soil. However, one cannot overemphasize the fact that technology is a tool for growth and development.

While it is true that the modern technology can offer solutions to many of the problems of developing countries including ours, it is not a panacea for improvement of quality of life and removal of poverty. This is illustrated by the fact that a third of world's population is still without electricity and an equal number does not have access to low-cost essential medicines! Where do we stand in the world order today?

We now rank at 115 in the world Human Development Index (HDI) – elevated from the low human development group of countries last year to medium human development as listed in the Human Development Report 2001 (HDR 2001) brought out by the United Nations Development Programme. Incidentally, HDI is a summary of human development. It measures the average achievements in a country in three basic dimensions of human development, viz., a long and healthy life, as measured by life expectancy at birth, knowledge as measured by the adult literacy rate and the combined primary, secondary, and tertiary gross enrolment ratio, and a decent standard of living as measured by the per capita Gross Domestic Product. Last year we ranked at position 128. Is our elevation to rank 115 this year an ocassion to celebrate? Not really. As the HDR 2001 says, 21 per cent of India's population is malnourished and 53 per cent of its children are underweight. 35 per cent of Indians live below poverty line and an equal number does not have access to essential drugs. 410 women die per 100,000 child births. Adult literacy still stands at 56.5 per cent. Infant Mortality Rate (IMR) still hovers around 70 per 1000 live births, much higher than several other developing countries. At the same time, immunisation against diseases such as tuberculosis and measles continues to be poor. In India, only 55 per cent children are immunised against measles and 72 per cent against tuberculosis. As a matter of fact, some of our neighbours in the sub-continent have better HDI rankings.

The report also has come up with a Technology Achievement Index (TAI) for 72 countries. This is in view of the fact that the theme for this year's report is "Making New Technologies Work for Human Development". Though TAI is a measure of country's progress in global technology, it is aimed at assessing the creation and diffusion of technology in the society. On TAI, India ranks 63, at the bottom of the group of countries described as "dynamic adapters". Why is it so? The reason is that the new technologies (say, information technology) and hence the New Economy still needs old-world's infrastructure like electricity, phone-connections, and above all skilled human resources, which are still in short supply in our country. We may have the world's seventh-largest number of scientists and engineers, but, we also have 44 per cent of adult illiteracy and an average of 5.1 years of education, as HDR 2001 says.

HDR 2001 notes that throughout history, technology has been a powerful tool for human development and poverty reduction. Today, people all over the world have high hopes that new technologies such as information and communication technology and biotechnology will lead to healthier lives, greater social freedoms, improved knowledge and more productive livelihoods. The possibilities are great – new technologies and globalization are creating a "network age". This has the effect of simultaneously changing the way technology is created, diffused into society and used. Surely, no country at any level of development, can afford not to participate in these networks. But, what is important is to weigh the benefits against risks of any new technology. A case in point is the possible risks posed by the transgenic crops. It is imperative that we have a thorough risk assessment of the consequences of development of transgenic crop varieties, or any other new technology for that matter. In any case, basic standards of safety should never be allowed to be breached by new technologies. Further, we must ensure that there are no lax standards for poor societies and another set of stricter standards for rich societies.

The task before science communicators is now cut out. It is essential to plan campaigns to educate people as regards the adoption of new technologies. We shall need to initiate debates and communicate through different means and modes to the people the benefits of new technologies and accompanying risks if any, how safe they are and what could be the strategies for their diffusion in the society. At the same time, we shall need to watch if the new technologies have been helping people lead a long and healthy life, have access to knowledge and information, literacy, and also enjoy a decent standard of living. Let us start discussing among ourselves and in groups the ways and means of achieving it in a foreseeable future. Let us sit and think how to go about the same. Do write to us your views in this regard. We still have a long way to go.

❑ *V.B. Kamble*

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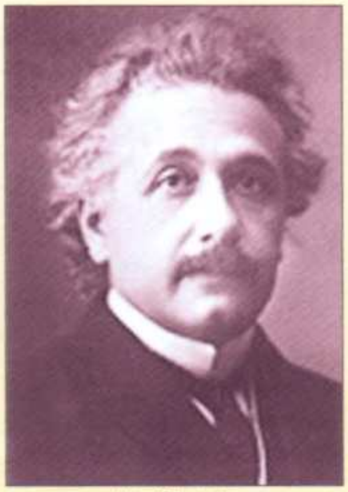
All Motion is Relative

❑ V.B. Kamble

Albert Einstein

Albert Einstein (14 March 1879 – 18 April 1955) was the only son of Hermann and Pauline Einstein. He grew up in Munich, where his father and his uncle ran a small electrochemical plant. Einstein was a slow child and disliked the regimentation of school. His scientific interests were awakened early and at home by the mysterious compass his father gave him when he was about four; by the algebra he learned from his uncle; and by the books he read, mostly popular scientific works of the day. A geometry text which he devoured at the age of twelve made a particularly strong impression.


Albert Einstein

When his family moved to Milan after a business failure, leaving the fifteen-year-old boy behind in Munich to continue his studies, Einstein quit the school he disliked and spent most of a year enjoying life in Italy. Persuaded that he would have to acquire a profession to support himself, he finished the Gymnasium in Aarau, Switzerland, and then studied physics and mathematics at the Eidgenössische Technische Hochschule (the Polytechnic) in Zurich, with a view toward teaching.

After graduation Einstein was unable to obtain a regular position for two years and did occasional tutoring and substitute teaching, until he was appointed an examiner in the Swiss Patent Office at Berne. The seven years Einstein spent at this job, with only evenings and Sundays free for his own scientific work, were years in which he laid the foundations of large parts of twentieth-century physics. They were probably also the happiest years of his life. He liked the fact that his job was quite separate from his thoughts about physics, so that he could pursue these freely and independently, and he often recommended such an arrangement to others later on. In 1903 Einstein married Mileva Maric, a Serbian girl, who had been a fellow student in Zurich. Their two sons were born in Switzerland.


Hendrik Antoon Lorentz

Einstein received his doctorate in 1905 from the University of Zurich for a dissertation entitled, "Eine neue Bestimmung der Moleküldimensionen" ("A New Determination of Molecular Dimensions"), a work closely related to his studies of Brownian motion. It took only a few years until he received academic recognition for his work, and then he had a wide choice of positions. His first appointment, in 1909, was as associate professor (*extraordinarius)* of physics at the University of Zurich. This was followed quickly by professorships at the German University in Prague, in 1911, and at the Polytechnic in Zurich, in 1912. Then, in the spring of 1914, Einstein moved to Berlin as a member of the Prussian Academy of Sciences and director of the Kaiser Wilhelm Institute for Physics, free to lecture at the university or not as he chose. As it turned out, he found the scientific atmosphere in Berlin very stimulating, and he greatly enjoyed having colleagues like Max Planck, Walther Nernst, and, later, Erwin Schödinger and Max von Laue. During World War 1, Einstein's scientific work reached a culmination in the general theory.of relativity, but in most other ways his life did not go well.

Mileva Einstein and their two sons spent the war years in Switzerland and the Einsteins were divorced soon after the end of the war. Einstein then married his cousin Elsa, a widow with two daughters. Einstein's health suffered, too. One of his few consolations was his continued correspondence and occasional visits with his friends in the Netherlands—Paul Ehrenfest and H. A. Lorentz, especially the latter, whom Einstein described as having "meant more to me personally than anybody else I have met in my lifetime" and as "the greatest and noblest man of our times."

Einstein became suddenly famous to the world at large when the deviation of light passing near the sun, as predicted by his general theory of relativity, was observed during the solar eclipse of 1919. His name and the term *relativity* became household words. The publicity, even notoriety, that ensued changed the pattern of Einstein's life.


Albert Abraham Michelson

In 1933 Einstein was considering an arrangement that would have allowed him to divide his time between Berlin and the new Institute for Advanced Study at Princeton. But when Hitler came to power in Germany, he promptly resigned his position at the Prussian Academy and joined the Institute. Princeton became his home for the remaining twenty-two years of his life. He became an American citizen in 1940.

During the 1930's Einstein was convinced that the menace to civilization embodied in Hitler's regime could be put down only by force. In 1939, at the request of Leo Szilard, Edward Teller, and Eugene Wigner, he wrote a letter to President Franklin D. Roosevelt pointing out the dangerous military potentialities offered by nuclear fission and warning him of the possibility that Germany might be developing nuclear weapons. This letter helped to initiate the American efforts that eventually produced the nuclear reactor and the fission bomb, but Einstein neither participated in nor knew anything about these efforts.

Einstein received a variety of honours in his lifetime – from the 1921 Nobel Prize in physics for his discovery of the law of the photoelectric effect (not relativity) to an offer (which he did not accept) of the presidency of Israel in 1952.

One of Einstein's last acts was his signing of a plea, initiated by Bertrand Russell, for the renunciation of nuclear weapons

Nobel Prizes awarded for work on Relativity and/or its applications.

Here is a list of Nobel Prizes awarded for work on Relativity and/or its applications in other fields.

1902	Hendrik Antoon Lorentz	the Netherlands	in Physics in recognition of his extraordinary service he rendered by his researches into the influence of magnetism upon radiation phenomena
1907	Albert Abraham Michelson	USA	in Physics for his optical precision instruments and the spectroscopic and metrological investigations carried out with their aid
1927	Arthur Holly Compton	USA	in Physics for his his discovery of the effect named after him
1933	Paul Adrien Mauric Dirac	Great Britain	in Physics for the discovery of new productive forms of atomic theory
1938	Enrico Fermi	Italy	in Physics for his demonstrations of the existence of new radioactive elements produced by neutron irradiation, and for his related discovery of nuclear reactions brought about by slow neutrons
1969	Murray Gell-Mann	USA	in Physics for his contributions and discoveries concerning the classification of elementary particles and their interactions
1974	Sir Martin Ryle	Great Britain	in Physics for his pioneering research in radio astrophysics: for his observations and inventions, in particular of the aperture synthesis technique
	Antony Hewish	Great Britain	in Physics for his decisive role in the discovery of pulsars
1983	Subramanyan Chandrasekhar	USA	in Physics for his theoretical studies of the physical processes of importance to the structure and evolution of the stars
1984	Carlo Rubbia	Italy	in Physics for their decisive contributions to the large project, which led to the discovery of the field particles W and Z, communicators of weak interaction
	Simon van der Meer	the Netherlands	-do-
1993	Russell A. Hulse	USA	in Physics for the discovery of a new type of pulsar, a discovery that has opened up new possibilities for the study of gravitation
	Joseph H. Taylor Jr.	USA	-do-

Note: It is interesting to note that Albert Einstein – the father of relativity – did not receive Nobel Prize for propounding the theory of relativity. He was awarded Nobel Prize in Physics for his services to Theoretical Physics, and especially for his discovery of the law of the photoelectric effect

and the abolition of war. He was drafting a speech on the current tensions between Israel and Egypt when he suffered an attack due to an aortic aneurysm; he died a few days later. But despite his concern with world problems and his willingness to do whatever he could to alleviate them, his ultimate loyalty was to his science. As he said once with a sigh to an assistant during a discussion of political activities: "Yes, time has to be divided this way, between politics and our equations. But our equations are much more important to me, because politics is for the present, but an equation like that is something for eternity."

Einstein's early interests lay in statistical mechanics and intermolecular forces. However, his predominant concern throughout the career was the search for a unified foundation for all of physics. The disparity between the discrete particles of matter and the continuously distributed electro-magnetic field came out most clearly in Lorentz' (1853-1928) electron theory, where matter and field were sharply separated for the first time. This theory strongly influenced Einstein. The problems generated by the incompatibility between mechanics and electromagnetic theory at several crucial points claimed his attention. Einstein's interest in these problems led to his most important early work – the special theory of relativity and the theory of quanta in 1905.

Arthur Holly Compton

The discovery of X-rays, radioactivity, the electron and the quantum theory brought about a sea change in our ideas and understanding of phenomena at the atomic level. The world of physics was, however, changing in far reaching ways - with ramifications for our understanding of the very shape of time, space and the universe. This part of the revolution was brought about by Albert Einstein, a brilliant and creative theorist and the only thinker ever to be ranked in the same class as Newton. To understand this part of the revolution, we shall need to go back to James Clerk Maxwell (1831-1879) and his ideas about light.

Ether – Unbroken from star to star

Maxwell had introduced a revolutionary set of equations that predicted the existence of electromagnetic fields and established that magnetism, electricity and light were a part of the same spectrum: the electromagnetic spectrum. Light, he maintained, was a wave, not a particle, and he thought that it travelled through an invisible medium he called "the ether", which filled all space. But physicists began to see a problem, not with Maxwell's electromagnetic field equations, but with his ideas about the ether.

Paul Adrien Mauric Dirac

Maxwell wasn't the first to come up with this idea that some invisible medium called the ether must fill the vastness of space, extending "unbroken from star to star". It dated back to the time of ancient Greeks. "There can be no doubt," Maxwell said in a lecture in 1873, "that the interplanetary and interstellar spaces are not empty but are occupied by a material substance or body, which is certainly the largest, and probably the most uniform, body of which we have any knowledge". The idea of the ether seemed necessary because, if light was a wave, it seemed obvious that it had to be a wave travelling in some medium. But accepting what "seems obvious" is not the way to do good science; if the ether existed, it should be possible to find some proof of its existence.

The most famous "failed" experiment

Albert Michelson (1852-1931), an American physicist, had an idea. If the ether that filled the universe were stationary, then the planet Earth would meet resistance as it moved through the ether, creating a current, a sort of "wind", in the ether. So it followed that a light beam moving with the current ought to be carried along by it, whereas a light beam travelling against the current should be slowed. While studying with Hermann von Helmholtz (1821-1894) in Germany, in 1881 Michelson built an instrument called an interferometer, which could split a beam of light, running the two halves perpendicular to each other, and then rejoin the split beam in a way that made it possible to measure differences in the speeds with great precision.

Michelson ran his experiment, but he was puzzled by his results. They showed no differences in light velocity for the two halves of the light beam. He concluded, "The result of the hypothesis of a stationary ether is .... shown to be incorrect, and the necessary conclusion follows that the hypothesis is erroneous".

But may be his results were wrong. He tried his experiment again and again, each time trying to correct for any possible error. Finally, in 1887, joined by Edward Morley, Michelson tried a test in Cleveland, Ohio. Using improved equipment, and taking every imaginable precaution against inaccuracy, this time surely they would succeed in detecting the ether. But the experiment failed again. Let us briefly describe the salient features of this momentous experiment.

The Experiment

If there is an ether pervading space, we move through it with at least the 3×10^4 m/sec speed of the earth's orbital motion about the Sun; if the Sun is also in motion, our speed through the ether is even greater (Figure 1). From the point of view of an observer on the Earth, the ether is moving past the Earth. To detect this motion, we can use the pair of light beams formed by a half silvered mirror (Figure 2). One of these light beams is directed to a mirror along a path perpendicular to the ether current, while the other goes to a mirror along a path parallel to the ether current. The optical arrangement is such that both beams return to the same viewing screen. The purpose of the clear glass plate is to ensure that both beams pass through the same thickness of air and glass.

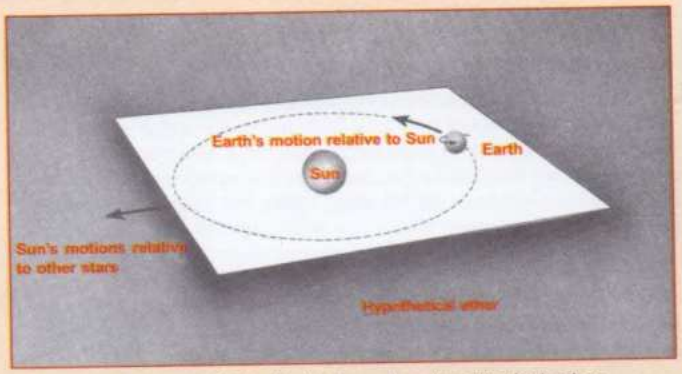


Fig. 1 : Motions of the Earth through a hypothetical ether

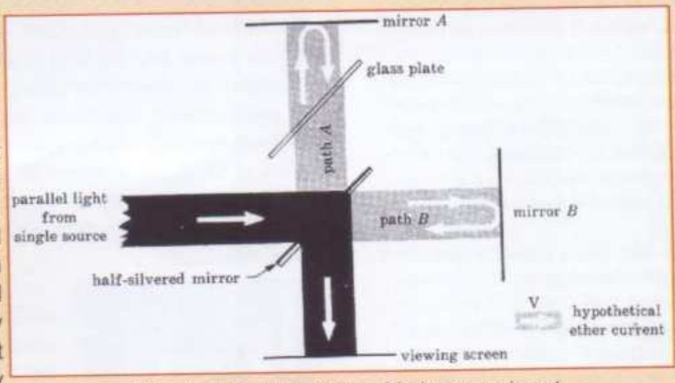


Fig. 2 : The Michelson - Morley experiment

If the path lengths of the two beams are exactly the same, they will arrive at the screen in phase and will interfere constructively to yield a bright field of view. The presence of an ether current in the direction shown, however, would cause the beams to have different transit times in going from the half silvered mirror to the screen, so that they would no longer arrive at the screen in phase but would interfere destructively. In essence this is the famous experiment performed in 1887 by Michelson and Morley.

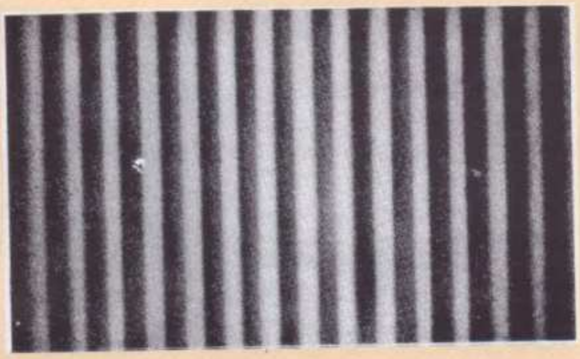


Fig. 3 : Fringe Pattern observed in Michelson - Morley experiment

In the actual experiment the two mirrors are not perfectly perpendicular, with the result that the viewing screen appears crossed with a series of bright and dark interference fringes due to differences in path length between adjacent light waves (Figure 3). If either of the optical paths in the apparatus is varied in length, the fringes appear to move across the screen as reinforcement and cancellation of the waves succeed one another at each point. The stationary apparatus, then, can tell us nothing about any time difference between the two paths. When the apparatus is rotated by 90°, however, the two paths change their orientation relative to the hypothetical ether stream, so that the beam formerly requiring the time t_A (along parth A) for the round trip now required t_B (along path B) and vice versa. If these times are different, the fringes will move across the screen during the rotation.

This information can be used to calculate the fringe shift expected on the basis of the ether theory. The expected fringe shift `n' in each path when the apparatus is rotated by 90° is given by

$$n = Dv^2 / \lambda c^2$$

Here, D is the distance between half silvered mirror and each of the other mirrors (made about 10 metres using multiple reflections), v is the ether speed - which is the Earth's orbital speed 3×10^4 (m/s), c is the speed of the light = 3×10^8 m/sec, and

The Four Dimensions

According to Einstein's views, space and time are more intimately connected with one another than it was supposed before and within certain limits, the notion of space may be substituted by the notion of time and vice versa. To make this statement more clear, let us consider a passenger in a train having his meal in the dining car. The waiter serving him will know that the passenger ate his soup, meals and dessert in the same place, that is, at the same table in the dining car. But, from the point of view of a person on the ground, the same passenger consumed the three courses at points along the track separated by many kilometres. We can hence make the following trivial statement: Events taking place in the same place but at different times in a moving system will be considered by a ground observer as taking place at different places.

Now, following Einstein's idea concerning the reciprocity of space and time, let us replace in the above statement the word "place" by the word "time" and vice versa. The statement will now read: Events taking place at the same time but in different places in a moving system will be considered by a ground observer as taking place at different times. This statement is far from being trivial. It means that if, for example, two passengers at the far ends of the dining car had their after-dinner coffee sipped simultaneously from the point of view of the dining-car waiter, the person standing on the ground will insist that the coffee was sipped at different times! Since according to the principle of relativity, neither of the two reference systems should be preferred to the other (the train moves relative to the ground or the ground moves relative to the train), we do not have any reason to take the waiter's impression as being true and ground observer's impression as being wrong or vice versa. Of course, this would not be apparent to you if you were the ground observer. This is so because the distance of, say, 30 metres between two passengers sipping their after dinner coffee at opposite ends of the dining car translates into a time interval of only 10^{-8} seconds, and there is no wonder that this is not apparent to our senses. It would become appreciable when the train travels close to the speed of light.

The transformation of time intervals into space intervals and vice versa was given a simple geometrical interpretation by the German mathematician H. Minkowski. He proposed that time or duration be considered as the fourth dimension supplementing the three spatial dimensions (x, y, z)and that transformation from one system of reference to another be considered as a rotation of co-ordinates systems in this four dimensional space. A point in these four dimensional space is called an event. Relativistic effects like the length contraction and the time dilation then become consequences of the rotation of these space-time co-ordinates.

These effects being relative, each of the two observers moving with respect to one another will see the other fellow as somewhat flattened in the direction of his motion and will consider his watch to be slow!

λ is the wave length of light used, about 5000Å (1Å=10^{-10}m), one then obtains n=0.2 fringe.

Since both paths experience this fringe shift, the total shift should amount to 2n or 0.4 fringe. A shift of this magnitude is readily observable, and therefore, Michelson and Morley looked forward to establishing directly the existence of the ether. *To everybody's surprise, no fringe shift whatever was found.* When the experiment was performed at different seasons of the year and in different locations, and when experiments of other kinds were tried for the same purpose, the conclusions were always identical: no motion through the ether was detected.

The negative result of the Michelson-Morley experiment had two consequences. First, it rendered untenable the hypothesis of the ether by demonstrating that the ether has no measurable properties – an ignominious end for what had once been a respected idea. Second, it suggested a new physical principle: the speed of light in free space is the same everywhere, regardless of any motion of source or observer. As a result, the Michelson-Morley experiment has become the most famous "failed" experiment in the history of science. **They had started out to study the ether, only to conclude that the ether did not exist.** But if this were true, how could light move in "waves" without a medium to carry it? What's more, the experiment indicated that the velocity of light is always constant.

Enrico Fermi

It was a completely unexpected conclusion. But the experiment was meticulous and the results irrefutable. Lord Kelvin (1824-1907), said in a lecture in 1900 at the Royal Institution that Michelson and Morley's experiment had been "carried out with most searching care to secure a trustworthy result," casting "a nineteenth century cloud over the dynamic theory of light". The conclusion troubled physicists everywhere, though. Apparently, they were wrong about the existence of the ether – and if they were wrong, then light was a wave that somehow could travel without a medium to travel through. What's more, the Michelson - Morley results seemed to call into question the kind of Newtonian relativity that had been around for a couple of centuries and by this time was well tested; the idea that the speed of an object can differ, depending upon the reference frame of the observer. Suppose two cars are travelling along on a road. (There weren't many cars or roads in 1887, but one gets the idea.). One car is going 80 kms per hour, the other 75 kms per hour. To the driver of the slower car, the faster car would be gaining ground at a rate of 5 kms per hour. Why would light be any different?

Stephen W. Hawking

But that's just what the Michelson and Morley experiment had shown; *Light does behave differently*. The velocity of light is always constant – no matter what. Astronauts travelling in their spaceship at a speed of 2,90,000 km/sec alongside a beam of light (which travels at 3,00,000 km/sec) would not perceive the light gaining on them by 10,000 km/sec. They would see light travelling at a constant 3,00,000 km/sec. The speed of light is a universal absolute!

The Special Theory of Relativity

Surprisingly, Einstein never received a Nobel prize for the most important paper that he published in 1905, the one that dealt with a theory that came to be known as the special theory of relativity.

He also tossed out the idea of the ether, which Michelson and Morley had called into question. Maxwell needed it because he thought light travelled in waves, and if that were so, he thought, it needed some medium in which to travel. But what if, as Max Planck's (1858-1947) quantum theory stated, light travels in discrete packets or quanta? Then it would act more like particles and wouldn't require any medium to travel in.

By making the assumptions — that the velocity of light is a constant, that there is no ether, that light travels in quanta and that motion is relative — he was able to show why the Michelson - Morley experiment came out as it did, without calling the validity of Maxwell's electromagnetic equations into question. But, where does "relativity" enter?

We mentioned earlier the role of the ether as a universal frame of reference with respect to which light waves were supposed to propagate. Whenever we speak of "motion", of course, we really mean motion relative to a "frame of reference". The frame of reference may be a road, the Earth's surface, the Sun, the center of our galaxy; but in every case we must specify it. Stones dropped in New Delhi and in Washington both fall "down", and yet the two move in opposite directions relative to the Earth's center. Which is the correct location of the frame of reference in this situation, the earth's surface or its center? The answer is that *all* frames of reference are equally correct, although one may be more convenient to use in a specific case. If there were an ether pervading all space, we could refer all motion to it, and the inhabitants of New Delhi and Washington would escape from their quandary. The absence of an ether, then, implies that there is no universal frame of reference, so that all motion exists solely relative to the person or instrument observing it.


Antony Hewish

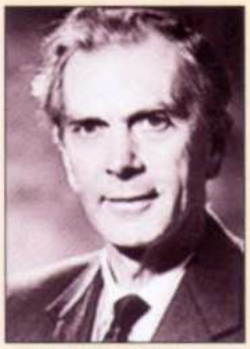
The theory of relativity resulted from an analysis of the physical consequences implied by the absence of a universal frame of reference. The special theory of relativity treats problems involving the motion of frames of reference at constant velocity (that is, both constant speed and constant direction) with respect to one another; the general theory of relativity, proposed by Einstein a decade later, treats problems involving frames of reference accelerated with respect to one another. The special theory has had a profound influence on all of physics.

The paper in which the young Albert Einstein in 1905 set out the special theory of relativity confronted common sense with several new and disquieting ideas. It abolished the ether, and it showed that matter and energy are equivalent. The new ideas derive from the central conception of relativity: that time does not run at the same pace for every observer. This bold conception lies at the heart of modern physics, all the way from the atomic to the cosmic scale. Yet it is still hard to grasp, and the paradoxes it pose continue to puzzle and to stimulate each generation of physicists.


Murray Gell-Mann

Two Axioms

The special theory of relativity is based upon two axioms. The first states that **the laws of physics may be expressed in equations having the same form in all frames of reference moving at constant velocity with respect to one another.** This axiom expresses the absence of a universal frame of reference. If the laws of physics had different forms for different observers in relative motion, it could be determined from these differences which objects are "stationary" in space and which are "moving". But because there is no universal frame of reference, this distinction does not exist in nature; hence the above axiom. Consequently, this axiom implies that two observers, each of whom appears to the other to be moving with a constant speed in a straightline, cannot tell which of them is moving.


Sir Martin Ryle

The second axiom of special relativity states that **the speed of light in free space has the same value for all observers, regardless of their state of motion.** This axiom follows directly from the result of the Michelson - Morley experiment, and implies that when both observers measure the speed of light, they will get the *same* answer.

Neither of these axioms was new in itself. The first axiom had long been implicit in the accepted laws of mechanics. The second one was beginning to be accepted as the natural interpretation of Michelson and Morley's experiment in 1887. What was new, then, in Einstein's analysis was not one axiom or the other but the confrontation of the two. They form the two principles of relativity not singly but together. This is how Einstein presented them jointly at the beginning of his paper.

So basically, in the special theory of relativity Einstein revamped Newtonian physics such that when he worked out the formulas, the relative speed of light always stayed the same. It never changes relative to anything else, even though other things change relative to each other. Mass, space and time all vary depending upon how fast you move. As observed by others, the faster you move, the greater your mass, the less space you take up and the more slowly time passes for you! **The more closely you approach the speed of light, the more pronounced these effects become.** Let us have a look at some of the consequences of the theory of relativity.


Subramanyan Chandrasekhar

Time Dilation

It follows at once from the two axioms combined that we have to revise the traditional idea of time. By tradition we take it for granted that time is the same everywhere and for everyone. Why not? It seems natural to assume that time is a universal "now" for every traveller anywhere in the universe. But, according to the theory of special relativity, time cannot run at the same pace for two observers, one of whom is moving relative to the other, if they are to get the same speed (that is for light) when they time a beam of light that is moving with one of them. Consider this example.

If you were an astronaut travelling at 90 percent of the speed of light (about 2,70,000 kms per second), you could travel for five years (according to your calendar watch) and you'd return to Earth to find that 10 years had passed for the friends you'd left behind. Or, if you could rev up your engines to help you travel at 99.99 percent of the speed of light, after traveling for only 6 months you'd find that 50 years had sped by our Earth during your absence!

Clocks moving with respect to an observer appear to tick less rapidly than they do when at rest with respect to him. If we, in the S frame, or the stationary frame of reference, observe the length of time t some event requires in a frame of reference S' in motion relative to us, our clock will indicate a longer time interval than the t_0 determined by a clock in the moving frame. This effect is called *time dilation*.

According to the theory of relativity, t and t_0 are related as

$$t = t_0 / \sqrt{1-v^2/c^2}$$

where v is the speed of the frame of reference S' (the moving frame) with respect to S (the stationary frame in which the observer is situated). Obviously t is greater than t_0 as v cannot be greater than c. thus, a stationary clock measures a longer time interval between events occurring in a moving frame of reference than does a clock in the moving frame.

Carlo Rubbia

Simon van der Meer

So the laws of relativity say that time is relative; it does not always flow at the same rate for the two travellers moving relative to each other. For example, moving clocks slow down. In the 1960s a group of scientists at the University of Michigan took two sets of atomic clocks with an accuracy to 13 decimal places. They put one set on airplanes flying around the world. The other identical set remained behind on the ground. When the airplanes with the clocks landed, and those clocks were compared to the clocks that stayed still, the clocks that had ridden on the airplanes had actually ticked fewer times than those that had stayed on the ground.

It may also be remarked that when v approaches c, the processes in the moving frame S' appear to further slow down to an observer in S. When v=c, t becomes infinitely long! This equation then sets a speed limit on the moving frame S' which is equal to the speed of light.

Let us now consider a common objection raised against the theory of relativity. Since there is no absolute motion of any sort, there is no "preferred" frame of reference. It is always possible to choose a moving object as a fixed frame of reference without violating any natural law. Consider two brothers - twins, one of them being on astronaut. When the Earth is chosen as a frame, the astronaut makes the long journey, returns, finds himself younger than his stay-at-home brother. All well and good. But what happens when the spaceship is taken as the frame of reference (S)? Now, it must be assumed that the Earth makes a long journey away from the ship and back again. In this case, it is the twin on the ship who is the stay-at-home. When the Earth gets back to the spaceship, will not the Earth rider be the younger? If so, the situation is more than a paradoxical affront to common sense. It is a flat logical contradiction. Clearly each twin cannot be younger than the other! A paradox! Not really. The application of the theory of relativity shows that the twin that travelled indeed remains young than his twin stay-at-home brother! (See Box).

The Twin Paradox

Indeed, all sorts of objections were raised against relativity. One of the earliest, most persistent objections centred around a paradox that had been mentioned by Einstein in his 1905 paper himself. The word "paradox" is used in the sense of something opposed to common sense, not something logically contradictory. It is usually described as a thought experiment involving twins. They synchronize their watches. One twin gets into a spaceship and makes a long trip through the space. When he returns, the twins compare their watches. According to the special theory of relativity, the traveller's watch will show a slightly earlier time. In other words, time on the spaceship would have gone at a slower rate than time on the earth!

It may seem at first sight that the two observers who part and then meet again must necessarily be in a symmetrical relation. Whatever journey each has made is, after all, relative; and it may therefore seem as if each observer is free to say that he has not travelled at all and that all the travelling has been done by the other. Indeed, we may ask, does not the first axiom of relativity say this? Does not the first axiom say that two observers cannot tell which of them has moved and which of them has stayed still?

No, it does not. What the first axiom of relativity says is something much sharper, something much more restricted and more precise. The first axiom says that if each of two observers seems to the other to be moving at a constant speed in a straight line, they cannot tell which of them is moving. But the axiom says nothing about observers in arbitrary motion. It says nothing about them if they do not move in straight lines and nothing about them if they do not move at a constant speed.

Here is the crux of the matter. Two observers who separate and meet again cannot fulfill the conditions of the first axiom of relativity throughout such a journey. Suppose one of them remains still. Then the other can travel in a straight line going and coming, but if he does this, he must turn back at some point-that is, he must change his speed. Or the traveller can move at a constant speed, but if he does this, he cannot move in a straight line—he must move in a curve if he is to come back to his starting point. Two observers who part and meet again can fulfill one condition of the first axiom of relativity, if they wish, but they cannot fulfill both.

And at once, as soon as a traveller departs from the conditions of the first axiom, he knows that he is moving. He feels the outside forces that produce a change of motion. If he is traveling in a straight line and has to come to rest, he knows physically that he is decelerating; he can tell that he is, by carrying an accelerometer and looking at it. Indeed, all he needs to carry is a bucket of water: if the surface begins to tilt, he knows that he is changing speed. In the same way, if the traveller is rounding a curve, he can tell that he is moving by the acceleration he feels—or by carrying an accelerometer or a bucket of water. We cannot detect a constant speed in a straight line: that is the first axiom of relativity. But we can detect any accelerated motion: that is a physical fact we have all experienced. Lying in a sleeping compartment in the dark at night, we may not be able to tell whether the train is moving or not. But we can tell when the train brakes, and we can tell when it rounds a bend. We can tell because we are thrown about; we act as our own accelerometer.

Therefore if I stay at home and you go on a journey and come back, the relation between us is not symmetrical. You can tell that you have travelled, even if you travel in a dark train—you can tell by carrying an accelerometer. And I can tell that I have stayed at home, because my accelerometer has recorded no change of speed or of direction. The traveller who makes a round trip can be distinguished from the stay-at-home.

Now consider what happens to your clock, the traveller's. Imagine your round trip broken down into a series of short, straight paths, along each of which you can keep your speed constant. Then along each short path your clock seems to me to run slower than mine. When you return, your clock should be behind mine, by the sum of these losses; and you should have aged less than I. Can this be so? It can, and it is. The difference in our timekeeping does not contradict any symmetry you may find in the situation. It does not contradict your finding that, along any short path, my clock also seems to you to be running slower than yours. Your findings do not add up because you do not remain faithful to the first axiom of relativity: your view of my time changes every time you move abruptly from one straight path to another. Only my view of your time losses accumulates steadily, because only I remain faithful to the first axiom of relativity throughout.

Source: The Clock Paradox by J. Bronowski

Length Contraction

Relativity also says that the faster an object moves, the more its size shrinks in the direction of its motion, as seen by a stationary observer. This implies that the length of an object in motion with respect to a stationary observer appears to be shorter than when it is at rest with respect to him, a phenomenon known as the *Lorentz - FitzGerald contraction*.


Russel A. Hulse


Joseph H. Taylor Jr.

Because the relative velocity of the two frames S and S', the one moving with velocity v with respect to the frame S, appears only as v^2 in the equations, it does not matter which frame we call S and which S'. If we find that the length of a rocket is L_0 when it is on its launching pad, we willl find from the ground that its length L when moving with the speed v is $L = L_0\sqrt{1-v^2/c^2}$, while to a man in the rocket, objects on the Earth behind him appear shorter than they did when he was on the ground by the same factor $\sqrt{1-v^2/c^2}$. The length of an object is a maximum when measured in a reference frame in which it is moving. The relativistic length contraction is negligible for ordinary speeds, but, it is an important effect at speeds close to the speed of light. At a speed v=1500 km/sec or about 0.005 percent of the speed of light, L measured in the moving frame S' would be about 99.9985% of L_0, but when v is about 90% of the speed of light L would be only about 44% of L_0! It is worth emphasising the fact that the contraction in length occurs only in the direction of the relative motion.

A Striking Illustration

A striking illustration of both time dilation and the length contraction occurs in the decay of unstable particles called µ mesons. µ mesons are created high in the atmosphere (several kilometres above the surface of the Earth) by fast cosmic ray particles arriving at the Earth from space and reach sea level in profusion travelling at 0.998 of the velocity of light. µ mesons ordinarily would decay into electrons only in 2 x 10^{-6} seconds. During this time they may travel a distance of only 600 metres. However, relative to mesons, the distance (through which they travel) gets shortened while relative to us, their life span gets increased. Hence, despite their brief life-spans, it is possible for mesons to reach the ground from the considerable altitudes at which they are formed.

Heavier the Faster

One more interesting consequence of the special theory of relativity is that as the objects approach the speed of light, their mass approaches infinity. The mass m of a body measured while in motion in terms of m_0 when measured at rest are related by,

$$m = m_0\sqrt{1-v^2/c^2}$$

The mass of a body moving at the speed of v relative to an observer is larger than its mass when at rest relative to the observer by the factor $1/\sqrt{1-v^2/c^2}$.

Relativistic mass increases are significant only at speeds approaching that of light. At a speed one tenth that of light the mass increase amounts to only 0.5 per cent, but this increase is over 100 per cent at a speed nine tenths that of light. Only atomic particles such as electrons, protons, mesons, and so on can have sufficiently high speeds for relativistic effects to be measurable, and in dealing with these particles the "ordinary" laws of physics cannot be used. Historically, the first confirmation of this effect was discovery by Bucherer in 1908 that the ratio e/m of the electron's charge to its mass is smaller for fast electrons than for slow ones; this equation, like the others of special relativity, has been verified by so many experiments that it is now recognized as one of the basic formulas of physics.

General Relativity and Black Holes

The Universe is expanding, exactly as the pure equations of general relativity predicted in 1917. Then, Einstein himself refused to believe the evidence of his own theory! Indeed, Einstein's equations provide the basis for the highly successful Big Bang description of the birth and evolution of the entire Universe. Within the expanding Universe, general relativity is required to explain the workings of exotic objects where space-time is highly distorted by the presence of matter where large masses produce strong gravitational fields. The most extreme version of this, and one that has caught the popular imagination, is the phenomenon of black holes. Black holes would trap light by their gravitational pull – or, in terms of general relativity, by bending space-time around themselves so much that it becomes closed, pinched off from the rest of the Universe. If a star keeps the same mass but shrinks inwards, or stays the same size while accumulating mass, density increases. Eventually, the distortion of space-time around it increases until, a situation is reached where the object collapses and folds space-time around itself, disappearing from all outside view. Not even light can escape from its gravitational grip, and it has become a black hole The notion of such stellar mass black holes seemed no more than a mathematical trick – something that surely could not be allowed to exist in the real Universe, until 1968, and the discovery of pulsars which are rapidly spinning neutron stars. A good deal of our understanding about black holes is due to the work of the legendary physicist of today, Stephen Hawking.

Mass? Energy? Or Mass Energy?

Here is yet another astounding consequnce of the theory of relativity. Using his famous equation, $E=mc^2$, Einstein showed that energy and mass are just two facets of the same thing. In this equation, E is energy, m is mass and c^2 is the square of the speed of light, which is a constant. So the amount of energy E, is equal to the mass of an object multiplied by the square of the speed of light.

In addition to its kinetic, potential, electromagnetic, thermal, and other familiar guises, then, energy can manifest itself as mass. The conversion factor between the unit of mass (kg) and the unit of energy (joule) is c^2, so 1 kg of matter has an energy. content of 9 x 10^{16} joules. Even a minute bit of matter represents a vast amount of energy.

Since mass and energy are not independent entities, the separate conservation principles of energy and mass are properly a single one, the principle of conservation of "mass energy". Mass can be created or destroyed, but only if an equivalent amount of energy simultaneously vanishes or comes into being, and vice versa.

It is this famous mass energy conversion relationship that is responsible for generation of energy in stars, atomic bombs, and the nuclear reactors!

Where common sense fails

The consequence of relativity described in the preceding paragraphs seems completely against all common sense. But common sense is based on everyday experience, and things don't get really strange with relativity until you venture into the very, very fast. Let us understand this aspect in some detail. Consider a rifleman in a jeep moving with velocity v with respect to the ground. The rifleman shoots a bullet in the forward direction with the muzzle velocity V. Now, the velocity of the bullet with respect to the ground, in accordance with the theory of relativity, will be, not V+v, but $(V + v) / (1 + vV/c^2)$, where c is the velocity of light. If both velocities V and v are small compared to the velocity of light, the second term in the denominator is practically zero and the old "common sense" formula holds. But either V or v, or both approach the velocity of light, the situation will be quite different. Consider $V = v = 0.75\ c$. According to the common sense, the velocity of the bullet with respect to the ground should be 1.5 c, i.e. 50 per cent more than the velocity of light. However, putting $V = 0.75\ c$ and $v = 0.75\ c$ in the above formula, we get 0.96 c for the velocity of bullet with respect to the ground, which is still less than the speed of light! In the limiting case, if we make V, and the velocity of the jeep v = c, we obtain, $(c + c) / (1 + (c^2) / c^2) = c$

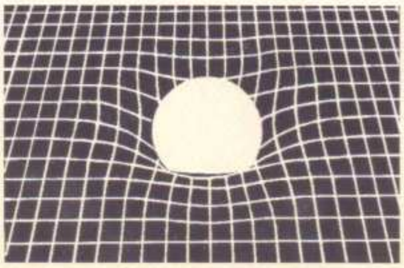


Fig. 4 : A heavy object placed on a streched rubber sheet makes an indentation. The presence of the Sun "indents" space-time in an analogous manner.

Fantastic as it may look at first sight, Einstein's law for the addition of two velocities is correct and has been confirmed by direct experiments. Thus Einstein's theory of relativity leads us to the conclusion that it is impossible to exceed the velocity of light by adding two (or more) velocities no matter how close each of these velocities is to that of light! *The velocity of light, therefore, assumes the role of a universal speed limit*, which cannot be exceeded no matter what we do! No matter how counter intuitive the idea of relativity may seem, we may remember that every experimental test of this theory till date has confirmed that Einstein was right!

The General Theory of Relativity

How does the general theory of relativity differ from the special theory? Let us have a brief look.

Strangely enough, it was another four years after Einstein's publication of his papers on the photoelectric effect, Brownian motion and the special theory of relativity, before he succeeded in securing a teaching position at the University of Zurich — and a poorly paying one at that. But by 1913, thanks to the influence of Planck, the Kaiser Wilhelm Institute near Berlin created a position for him. Ever since his 1905 publications, Einstein had been working on a bigger theory: his general theory of relativity. The special theory had applied only to steady movement in a straight line. But what happened when a moving object sped up or slowed down or curved in a spiral path? In 1916, he published his general theory of relativity, which had vast implications, especially on the cosmological scale. **Many physicists consider it the most elegant intellectual achievement of all time.**

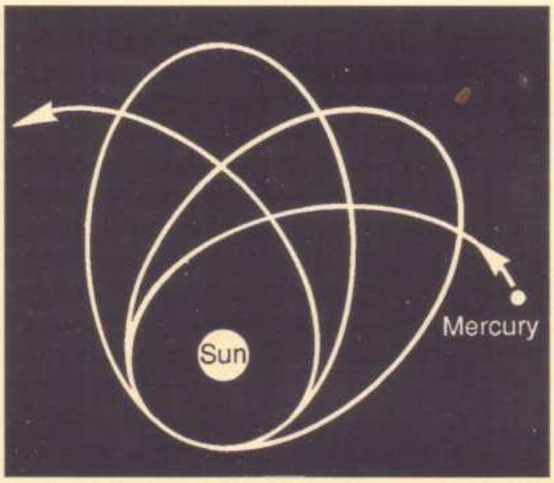


Fig. 5 : The curious shape of the orbit of Mercury is explained by general relativity

The general theory preserves the tenets of the special theory while adding a new way of looking at gravity — because gravity is the force that causes acceleration and deceleration and curves the paths of moons around planets, of planets around the sun, and so on. Einstein realized that there is no way to tell the difference between the effects of gravity and the effects of acceleration. So he abandoned the idea of gravity as a force and talked about it instead as an artifact of the way we observe objects moving through space and time. According to Einstein's relativity, a fourth dimension — time — joins the three dimensions of space (height, length and width), and the four dimensions together form what is known as the space-time continuum.

To illustrate the idea that acceleration and gravity produce essentially the same effects, Einstein used the example of an elevator, with its cables broken, falling from the top floor of a building. As the elevator falls, the effect on the occupants is "weightlessness", as if they were aboard a spaceship. For that moment they are in free fall around the Earth. If the people inside couldn't see anything outside the elevator, they would have no way to tell the difference between this experience and the experience of flying aboard a spaceship in orbit.

Einstein made use of this equivalence to write equations that saw gravity not as a force, but as a curvature in space time — much as if each great body were located on the surface of a great rubber sheet (Figure 4). A large object, such as a star, bends or warps space time, much like a large ball resting on a rubber sheet would cause a depression or sagging on its surface. The distortions caused by masses in the shape of space and time result in what we call gravity. What people call the "force" of gravity is not really a characteristic of objects like stars or planets, but comes from the shape of space itself.

In fact, this curvature has been confirmed experimentally. Einstein made predictions in three areas in which his general theory was in conflict with Newton's theory of gravity:

(1) Einstein's general theory allowed for a shift in the perihelion (the point nearest the Sun) of a planet's orbit as shown in Figure 5. Such a shift in Mercury's orbit had baffled astronomers for years to which the general theory of relativity offered an explanation.

(2) Light in an intense gravitational field should show a red shift as it fights against gravity to leave a star. Indeed, comparing the vibration frequencies of spectral lines in sunlight with light emitted by terrestrial sources, astronomers have found that in the former case all vibration periods are lengthened (or frequencies reduced implying the "red shift") by about 2×10^{-4} per cent, which is exactly the value predicted by Einstein's theory. Consequenlty, the spectrum observed appears to shift towards the red and as observed on the Earth, exhibiting the gravitational red shift.

(3) Light should be deflected by a gravitational field much more than Newton predicted (Figure 6). On March 29, 1919, a total solar eclipse occurred over Brazil and the coast of West Africa. In the darkened day-time sky, the measurements of the nearby stars were taken. Then they were compared with those taken in the midnight sky six months earlier when the same stars had been nowhere near the Sun. The predicted deflection of the star-light was observed and Einstein was proved right. He rapidly became the most famous scientist in the world, and his name became a household word.

Always a Catalyst

Germany – one of the premier cradles of great work in all the sciences – rapidly became less and less hospitable to the large group of outstanding scientists who worked there, especially the

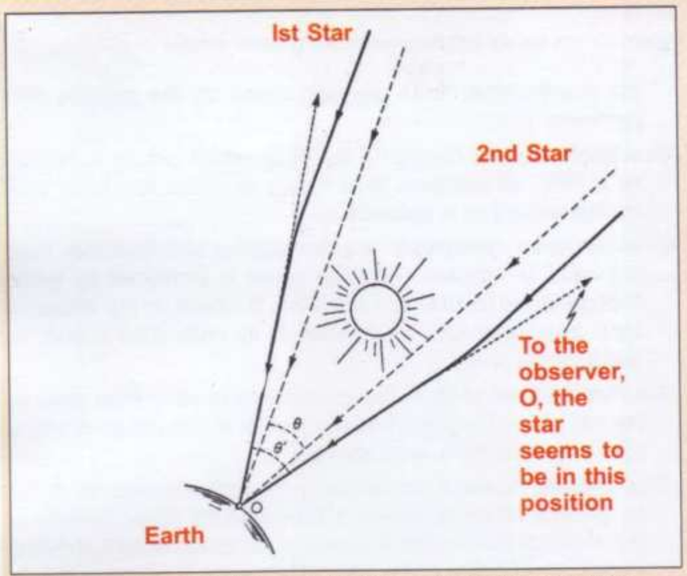


Fig. 6 : The deviation of light from a star when the light passes closed to the sun

many who, like Einstein, were counted among the Nazis' Jewish targets. By the 1930s an exodus had begun, including many non-Jewish scientists who left on principle, no longer willing to work where their colleagues were persecuted. In 1930, Einstein left Germany for good. He came to the United States to lecture at the California Institute of Technology, and never went back to Germany afterward. He accepted a position at the Institute of Advanced Study in Princeton, New Jersey, where he became a permanent presence, and in 1940 he became an American citizen.

Always a catalyst among his colleagues for thoughtful reflection, Einstein remained active throughout his life in the world of Physics. But even this renegade found, as Planck did, that Physics was changing faster than he was willing to accept. On the horizon loomed challenges to reason that he was never able to accept – such as Niels Bohr's complementarity and Werner Heisenberg's uncertainty principle. "God does not play dice with the universe," Einstein would grumble, or "God may be subtle, but He is not malicious." During the last decades of his life Einstein spent much of his time searching for a way to embrace both gravitation and electromagnetic phenomena. He never succeeded, but continued to be, to his final days, a solitary quester, putting forward his questions to nature and humanity, seeking always the ultimate beauty of truth.

Einstein received the Nobel prize in Physics for the year 1921, not for relativity, but for the interpretation of the photoelectric effect. It was given "for his services to theoretical physics, and especially for his discovery of the law of the photoelectric effect".

Relativity – Any challenge?

True, there have been a few challenges to the theory of relativity once in a while – both theoretical and experimental. Nearly three decades ago, our own E.C.G. Sudarshan had predicted the possibility of "Tachyons" – the particles that travelled at a speed greater than light, but, in a different realm. They could not travel at a speed lower than the speed of light. It may be noted that such particles cannot carry any information.

There have even been challenges to the constancy of the speed of light in vacuum. Recently, there has been a measurement by a team of Italian physicists that appears to indicate that they can send a faster-than-light pulse of microwaves over more than a metre. In Einstein's theory, time races forwards as if on a light beam. If an object were to travel faster than c, it would move backwards in time, violating the principle of causality which says that cause must always precede the effect. The alternative seems nonsensical as illustrated by the following limerick:

There was a young lady named Bright
whose speed was far faster than light
She went out one day
In a relative way
And returned the previous night.

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Relativity : Glossary

Important terms used in connection with Relativity are given below. The terms given do not necessarily appear in the present article.

Absolute zero : The temperature of –273.16ºC, or – 459.69ºF, or 0 K, thought to be the temperature at which molecular motion vanishes and a body would have no heat energy.

Aphelion: The point of a planetary orbit farthest from the Sun.

Black hole: Black hole s a collapsed object, such as a star, that has become invisible. It is formed when a massive star runs out of thermonuclear fuel and is crushed by its own gravitational force. It has such a strong gravitational force that nothing can escape from its surface, not even light. Though invisible, it can capture matter and light from the outside.

Cosmological constant: The multiplicative constant for a term proportional to the metric in Einstein's equation relating the curvature of space to the energy-momentum tensor.

Cosmology: The study of the overall structure of the physical universe.

Curvature of space: The deviation of a spacelike three-dimensional subspace of curved space-time from euclidean geometry.

Curved space-time: A four-dimensional space, in which there are no straight lines but only curves, which is a generalization of the Minkowski universe in the general theory of relativity.

Equivalence principle: In general relativity, the principle that the observable local effects of a gravitational field are indistinguishable from those arising from acceleration of the frame of reference. Also known as Einstein's equivalence principle; principle of equivalence.

Event: A point in space-time.

FitzGerald-Lorentz contraction: The contraction of a moving body in the direction of its motion when its speed is comparable to the speed of light. Also known as Lorentz contraction: Lorentz-FitzGerald contraction.

Four-vector: A set of four quantities which transform under a Lorentz transformation in the same way as the three space coordinates and the time coordinate of an event. Also known as Lorentz four-vector.

Four-velocity: A four-vector whose components are the rates of change of the space and time coordinates of a particle with respect to the particle's proper time.

Frame of reference: A coordinate system for the purpose of assigning positions and times to events. Also known as reference frame.

Geodesic: A curve joining two points in a Riemannian manifold which has minimum length.

Gravitation: The mutual attraction between all masses in the universe. Also known as gravitational attraction.

Gravitational collapse: The implosion of a star or other astronomical body from an initial size to a size hundreds or thousands of times smaller.

Gravitational constant: The constant of proportionality in Newton's law of gravitation, equal to the gravitational force between any two particles times the square of the distance between them, divided by the product of their masses. Also known as constant of gravitation.

Gravitational field: The field in a region in space in which a test particle would experience a gravitational force; quantitatively, the gravitational force per unit mass on the particle at a particular point.

Gravitational-field theory: A theory in which gravity is treated as a field, as opposed to a theory in which the force acts instantneously at a distance.

Gravitational radiation: A propagating gravitational field predicted by general relativity, which is produced by some change in the distribution of matter; it travels at the speed of light, exerting forces on masses in its path. Also known as gravitational wave.

Gravitational red shift: A displacement of spectral lines towards the red when the gravitational potential at the observer of the light is greater than at its source.

Gravitational wave: A propagating gravitational field predicted by general relativity, which is produced by some change in the distribution of matter; it travels at the speed of light, exerting forces on masses in its path. Also known as gravitational radiation.

Graviton: A theoretically deduced particle postulated as the quantum of the gravitational field, having a rest mass and charge of zero and a spin of 2.

Gravity: The gravitational attraction at the surface of a planet or other celestial body.

Lorentz-FitzGerald contraction: The contraction of a moving body in the direction of its motion when its speed is comparable to the speed of light. Also known as FitzGerald-Lorentz contraction.

Lorentz four-vector: A set of four quantities which transform under a Lorentz transformation in the same way as the three space coordinates and the time coordinate of an event. Also known as Four-vector.

Lorentz frame: Any of the family of inertial coordinate systems, with three space coordinates and one time coordinate, used in the special theory of relativity; each frame is in uniform motion with respect to all the other Lorentz frames, and the interval between any two events is the same in all frames.

Lorentz invariance: The property, possessed by the laws of physics and of certain physical quantities, of being the same in any Lorentz frame, and thus unchanged by a Lorentz transformation..

Lorentz transformation: Any of the family of mathematical transformations used in the special theory of relativity to relate the space and time variables of different Lorentz frames.

Mass-energy conservation: The principle that energy cannot be created or destroyed; however, one form of energy is that which a particle has because of its rest mass, equal to this mass times the square of the speed of light.

Mass-energy relation: The relation whereby the total energy content of a body is equal to its inertial mass times the square of the speed of light.

Minkowski universe: Space time as described by the four coordinates (x, y, z, ict), where i is the imaginary unit and c is the speed of light; Lorentz transformations of space-time are orthogonal transformations of the Minkowski world. Also known as Minkowski world.

Neutron star: A star that is supposed to occur in the final stage of stellar evolution; it consists of a superdense mass mainly of neutrons, and has a strong gravitational attraction from which only neutrinos and high-energy photons could escape so that the star is invisible.

Perihelion : The point of planetary orbit closest to the Sun.

Principle of covariance:In classical physics and in special relativity, the principle that the laws of physics take the same mathematical form in all inertial reference frames.

Principle equivalence: In general relativity, the principle that the observable local effects of a gravitational field are indistinguishable from those arising from acceleration of the frame of reference. Also known as Einstein's equivalence principle; Equivalence principle.

Pulsar: Variable star whose luminosity fluctuates as the star expands and contracts; the variation in brightness is thought to come from the periodic change of radiant energy to gravitational energy and back. Also known as pulsating star.

Pulsating star: Variable star whose luminosity fluctuates as the star expands and contracts; the variation in brightness is thought to come from the periodic change of radiant energy to gravitational energy and back. Also known as pulsar.

Quasar: Quasi-stellar astronomical object, often a radio source; all quasars have large red shifts; they have small optical diameter, but may have large radio diameter. Also known as quasi-stellar object (QSO).

Relative: Related to a moving point; apparent, as relative wind, relative movement.

Relative momentum: The momentum of a body in a reference frame in which another specified body is fixed.

Relative motion: The continuous change of position of a body with respect to a second body, that is, in a reference frame where the second body is fixed.

Relativistic beam: A beam of particles travelling at a speed comparable with the speed of light.

Relativistic electrodynamics: The study of the interaction between charged particles and electric and magnetic fields when the velocities of the particles are comparable with that of light.

Relativistic kinematics: A description of the motion of particles compatible with the special theory of relativity, without reference to the causes of motion.

Relativistic mass: The mass of a particle moving at a velocity exceeding about one-tenth the velocity of light; it is significantly larger than the rest mass.

Relativistic mechanics: Any form of mechanics compatible with either the special or the general theory of relativity.

Relativistic particle: A particle moving at a speed comparable with the speed of light.

Relativistic quantum theory: The quantum theory of particles which is consistent with the special theory of relativity, and thus can describe particles moving close to the speed of light.

Relativistic theory: Any theory which is consistent with the special or general theory of relativity.

Relativity: Theory of physics which recognizes the universal character of the propagation speed of light and the consequent dependence of space, time, and other mechanical measurements on the motion of the observer performing the measurements; it has two main divisions, the special theory and the general theory.

Slowing of clocks: According to the special theory of relativity, a clock appears to tick less rapidly to an observer moving relative to the clock than to an observer who is at rest with respect to the clock. Also known as time dilation effect.

Space coordinates: A three-dimensional system of cartesian coordinates by which a point is located by three magnitudes indicating distance from three planes which intersect at a point.

Spacelike surface: A three-dimensional surface in a four-dimensional space-time which has the property that no event on the surface lies in the past or the future of any other event on the surface.

Spacelike vector: A four vector in Minkowski space whose space component has a magnitude which is greater than the magnitude of its time component multiplied by the speed of light.

Space-time: A four-dimensional space used to represent the universe in the theory of relativity, with three dimensions corresponding to ordinary space and the fourth to time. Also known as space-time continuum.

Space-time continuum: A four-dimensional space used to represent the universe in the theory of relativity, with three dimensions corresponding to ordinary space and the fourth to time. Also known as space-time.

Special relativity: The division of relativity theory which relates the observations of observers moving with constant relative velocities and postulates that natural laws are the same for all such observers.

Time-dilation effect: According to the special theory of relativity, a clock appears to tick less rapidly to an observer moving relative to the clock than to an observer who is at rest with respect to the clock. Also known as slowing of clocks.

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Letters to the Editor

I read your almost all articles (Biography of Scientists). It needs careful reading as each word carry weight. A lot of information is compressed in each sentence. The articles do project the then prevailing situations/ conditions. The centre point of the articles are personalities and you have tried to cover the entire work done by those persons. The articles do arouse the more curiosity to know more about the experiments & inventions. I feel, it is also the responsibility of "Vigyan Prasar" to either direct the readers for further material wherever possible through the articles.

Satish M. Kukade

1, Mukund Niwas, Ram Maruti Road, Dadar, Mumbai-400028

Really I am enjoying reading the Monthly Newsletter of Vigyan Prasar, DREAM 2047, the informative articles on various topics, editorial etc on quality paper. The February 2001 (Vol3 No 5) issue on "Earthquakes" was very much informative. I suggest to go in for e-newsletter as it will be quick and less expensive for those who have access to E-mail.

H.J. Shiva Prasad,

Senior Engineer, TCE Consulting Engineer Limited,
34, Sant Tukaram Road, Carnac, Mumbai-400009

Dream 2047 is also available on the Internet (www. vigyanprasar.com)
- Editor

Intellectual Property Rights
(Part-III : International & Regional Agreements)

❑ *Subodh Mahanti*

In the first two parts of the article we have described briefly about the general aspects of intellectual property rights, patent system, industrial design, trademark and copyright. In this part we shall briefly discuss about WTO, WIPO, TRIPS and other international/regional agreements related to intellectual property.

The General Agreement on Tariffs and Trade (GATT) originated after World War II (1939-45). The Agreement was originally a part of a draft charter for an International Trade Organisation (ITO), the third leg of the Bretton-Woods post-war order along with the IMF and the World Bank. The "Havana Charter" of the ITO contained the GATT, which governed trade, and also wide-ranging rules relating to employment, commodity agreements, restrictive business practices, international investment and services. GATT was signed by 23 nations at a trade conference in 1947 and became effective in January 1948. The ITO failed to win ratification by the US Congress in 1950 and never came into being. However, the GATT remained in use to govern international trade. The GATT came into force in 1948. Till 1994 (when it was replaced by WTO), GATT had eight "rounds" of negotiation which reduced tariffs and struggled to produce rules to govern international trade. The last round of negotiations, called the Uruguay Round, began in 1986 and ended in 1994. The Uruguay Round of negotiations took steps towards opening trade in investments and services among contracting States and strengthening protection for intellectual property — the legally protectable creative works. The Uruguay Round also provided for establishment of the WTO which replaced the GATT. The 1994 GATT Treaty was one of the most ambitious agreements to be signed by such a large number of States. All of the 128 contracting States to 1994 GATT Agreement eventually transferred membership to the WTO.

The World Trade Organisation (WTO) came into existence in 1995 by an international treaty signed by the member States of the General Agreement on Tariffs and Trade (GATT). The GATT was established in the wake of the Second World War. WTO is the only international organisation dealing with the global rules of trade between nations. The stated objective of the WTO is to ensure that trade flows smoothly, productably and freely as possible. The multilateral trading system, which is at the heart of WTO system constitute the WTO's agreements negotiated and signed by a large majority of the World's trading nations, and ratified in their parliaments. The highest authority of WTO is the Ministerial Conference. It constitutes of representatives of all member countries usually trade ministers. The Conference convenes at least every two years. WTO has other subsidiary bodies which carry out day-to-day activities. The General Council composed of all WTO members reports to the Ministerial conference. The General Council also convenes in two particular forms; the Disputes Settlement Body and the Trade Policy Review Body. The General Council delegates its responsibility to three other bodies — the Councils for Trade in Goods, Trade in Services and Trade-related Aspects of Intellectual Property Rights.

The headquarters of WTO are at Geneva, Switzerland. Its main functions are :

- Administering WTO trade agreements
- Acting as forum for trade negotiations
- Handling trade disputes
- Monitoring national trade policies
- Technical assistance and training for developing countries
- Co-operation with other international organisations

On 30 November 2000 the number of countries that were members of the WTO stood at 140. It may be noted that though the words "country" and "nation" are frequently used to describe WTO members, but a few members are officially "Customs territories" and not necessarily countries in the usual sense of the word. While the WTO operates a similar dispute settlement process as followed by the GATT, it has stronger power to enforce agreement including authority to issue trade sanctions against a contracting State that refuses to evoke an offending law or practice.

The World intellectual Property Organisation (WIPO) "The Convention Establishing the World Intellectual Property Organisation" was signed at Stockholm in 1967 and entered into force in 1970. It is one of the specialised agencies of the United Nations (UN) system of organisations. Though specialised agency is the part of the family of United Nations Organisations it retains its independence. Every specialised agency has its own membership. However, all members of the United Nations are entitled to become members of all specialised agencies. Over the years, Governments have negotiated and adopted multilateral treaties in the various intellectual related fields, each of which establishes a "Union" of countries which agree to grant to people residing in the other countries of the Union the same protection as they grant to their own people. A Union consists of all the States that are party to a particular treaty. Member countries of such Union follow certain common rules, standards and practices. The 'Unions' founded on the multilateral treaties in the various fields of intellectual property are administered by the WIPO. WIPO also provides a framework and the services necessary for revising these treaties and establishing new ones. It requires a constant effort for international cooperation and negotiation.

There are three major functions of WIPO :

1. Registration activities
2. Promotion of intergovernmental cooperation
3. Substantive or programme activities

The registration activities of WIPO are concerned with the receiving and the processing of international applications under the Patent Cooperation Treaty (PCT) or for the International Registration of Marks or deposit of industrial designs.

Inter governmental cooperations in the administration of intellectual property are concerned with the following :

- Collection of patent documents used for search and reference and devising means of easier access of the information contained in the patent documents.
- The maintenance and updation of international classification systems.
- The compilation of more and more sophisticated statistics.

- Regional surveys of industrial property and copyright law administration.
- The programme activities form the major part of WIPO activities and they include wider acceptance of existing treaties, (whenever necessary) updating treaties through their revision, establishing new treaties and organising and participating in development cooperation activities.
- The WIPO has its headquarters at Geneva. It has four different organs — the General Assembly, the Conference, the Coordination Committee and the International Bureau of WIPO.
- The General Assembly, the supreme organ of WIPO, consists of all the States which are members of WIPO and are also members of any of the Unions. Its important functions are:
  - *Appointment of Director General upon nomination by the Coordination Committee.*
  - *Reviewing and approving reports of the Coordination Committee as well as report of the Director General concerning WIPO.*
  - *Adoption of the financial regulation of WIPO and biennial budget of expenses common to the Unions.*
  - *Approval of the measures proposed by the Director General for administering the international agreements designed to promote the protection of intellectual property.*
- The Coordination Committee acts both as an advisory organ on questions of general interest and as an executive organ of the General Assembly and the Conference.
- The Conference consists of all the States which are members of WIPO whether or not members of any of the Unions. Its main functions are :
  - *Acts as a forum for exchange of views, between all State members of WIPO on matters relating to intellectual property.*
  - *It establishes the biennial development cooperation programmes for developing countries and adopts budget for the purpose.*
  - *It determines which States and organisations will be admitted to its meetings as observers.*
  - *It is competent to adopt amendments to the Conventions establishing WIPO.*
- The International Bureau of WIPO or the Secretariat is headed by the Director General.

Like in any other specialised agency of the United Nations only States can be members of WIPO. The membership is open to any State which is a member of any of the Unions and to any State which is not a member of any of the Unions provided that it is a member of United Nations or the International Atomic Energy Agency or is a party to Statute of the International Court of Justice. The General Assembly of WIPO can also invite any State to become a member.

The Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) Agreement The TRIPS Agreement, which is binding on all WTO members, came into force on January 1, 1995. The Agreement is based on negotiations held during the Uruguay Round of multilateral trade negotiations on aspects of intellectual property rights which impacted an international trade. The Uruguay Round of negotiations was concluded on December 15, 1993. The TRIPS Agreement is contained in an Annex to the WTO Agreement establishing the World Trade Organisation (WTO), which began to work on January 1, 1995. The TRIPS Agreement is often described as one of the three 'Pillars' of the WTO—the other two are trade in goods and trade in services. The TRIPS Agreement makes protection of intellectual property rights an integral part of the multilateral trading system as embodied in the WTO.

Though TRIPS Agreement entered into force on January 1, 1995 no member of WTO was obliged to apply the provisions of the TRIPS Agreement before the expiry of one year following the date of entry into force of the Agreement that is before January 1, 1996. In addition to the transition period of one year applicable to all countries including the developed ones, the Agreement allowed countries different periods of time to delay its provisions. Developing country members of WTO were granted a delay of a further period of four years from the date of application of the Agreement (that is until January 1, 2000). Moreover a developing country which is obliged by the Agreement to extend product patent protection to types not previously patentable in that country (for example India), was given an additional period of five years (that is until January 1, 2005) before applying the provisions of the Agreement to such products. Least developed country members of WTO are not required to apply the provision of the Agreement for a period of 10 years from the general date of application of the Agreement. In the WTO, least developed countries are those recognised as least developed countries by the United Nations. Presently there are 48 least developed countries on the UN list. All of these are not members of WTO. It should be highlighted that all members, even those availing themselves of the larger transitional periods, are required to comply with obligations on national treatment (equal treatment for foreign and domestic individuals and companies) and most favoured-nation treatment (non-discrimination between foreign individuals and companies) as stipulated in the TRIPS Agreement.

While members are free to determine the appropriate method of implementing the provisions of the TRIPS Agreement within their own legal system and practice, a basic principle concerning the nature and scope of obligation under the TRIPS Agreement is that members must implement the provisions under the Agreement and accept the treatment provided for in the Agreement to the nationals of other members. Members are free to implement more extensive protection than is required, provided that such additional protection does not contravene other provisions of the Agreement.

The term 'intellectual property' in TRIPS Agreement refers to copyright and neighbouring rights, trademarks, geographical indicators, industrial designs, patent, layout designs (topographies) of integrated circuits and undisclosed information.

The TRIPS Agreement stipulates that member-countries of WTO must comply with the substantive obligation of the Paris Convention on Industrial property and the Berne Convention on copyright (except the provisions on moral rights) in their most recent versions. All the substantive provisions of these two main Conventions are incorporated by references. WTO member countries under TRIPS Agreement are not only required to apply these main provsions, but also to apply them to individuals and companies of other WTO member countries. In addition to these main provisions TRIPS, Agreement has introduced additional obligations in areas not addressed or inadequately addressed by these Conventions. For this reason the TRIPS Agreement is sometimes referred to as "Berne and Paris-Plus" Agreement.

The TRIPS Agreement stipulates domestic procedures and remedies for the enforcement of intellectual property right. Besides laying down certain general principles applicable to all IPR enforcement procedures, it sets out provisions and civil and administrative procedures and remedies, provisional measures, special requirements related to border measures and criminal procedures, which specify in certain amount of detail the procedures and remedies that must be available so that the right holders may effectively protect their rights.

The TRIPS Agreement makes disputes between WTO members about the respect of the TRIPS obligations subject to the WTO's dispute settlement procedures.

The TRIPS Agreement provides certain basic principles, such as national and most-favoured-nation treatment. It also provides some general rules to ensure that procedural difficulties in acquiring or maintaining IPRs do not nullify the substantive benefits that should flow from the Agreement.

Budapest Treaty : The Budapest Treaty on the International Recognition of the Deposit of Micro-organism for the Purposes of Patent Protection" was signed on April 29, 1977. The Treaty, which was subsequently amended on September 26, 1980, provides for the deposit of micro-organisms in an International Depository Authority. What the Treaty calls "international depository authority" is a scientific institution capable of collecting micro-organisms. An institution of this type acquires the status of an "international Depository Authority" furnishing through the contracting State in which the institute is located of assurance to the Director General of WIPO to the effect that the said institution would comply with certain requirements of the Treaty. A deposit would require to meet the descriptive requirements of patent legislation governing invention involving a micro-organism or the use of a micro-organism. Any deposit can be accessed by for the purpose of testing and experimenting and for commercial use when the patent expires. Every deposit would carry the following minimum details.

- The name and address of the depositors.
- The original date of submission
- Identification of reference
- Accession number of the deposit
- Scientific description of the deposit

On 14 January 2000 there were 48 members of the Budapast Treaty. Only those countries which are members of the Paris convention are qualified for becoming members of the Budapest Treaty. Recently India has decided to be a member of the Treaty.

Biodiversity Convention : This was the result of the growing realisation of the need to arrive at balanced interface between intellectual property convention and issues related to biodiversity, biotechnology and bio-conservation. The convention, which was proposed in 1992 at the Rio "Earth Summit, has been ratified by more than 169 countries. Among its key features are :

i) The conservation and sustainable use of different components of bio-diversity.

ii) Fair and equitable sharing of benefits arising out of the utilisation of genetic resources.

Biodiversity and the ensuing benefits from it have been redefined from humankind's common heritage to national goods so that any nation can protect and trade them as commodities.

Eurasian Patent Convention (EAPC) was formed by the Members of the Commonwealth of Independent States (CIS). on August 12, 1995. However, it started functioning from January 1, 1996 with its office at Moscow. For patenting in all Member States of EAPC, an inventor needs to file only one patent application with a single payment. The official language is Russian and follows the first-to file system. The term of patent is 20 years.

Geneva Convention : The Geneva Convention for the Protection of Producers of Phonograms Against Unauthorised Duplication of Their Phonograms concluded on January 1, 1997. The convention, administered by the International Bureau of WIPO, "provides for the obligation of each contracting state to protect a producer of phonograms, who is a national of another contracting state against the making of duplicates without the consent of the producer, against the

The Organisation Africaine de la Proprite Intellectuelle (OAPI) : It was formed in 1958 by the twelve former French Overseas Territories that gained independence. A single patent granted by OAPI from any of its regional offices become separately effective in all the Member states. However, when a Member State revokes a patent in its territory, it remains effective in the other Member States.

Lisbon Agreement : The Lisbon Agreement for the Protection of Appellations of Origin and their International Registration was concluded in 1958. The Agreement was subsequently revised in 1967 and was amended in 1979. The Agreement is open to the states party to the Paris Convention. Its aim is to provide for the protection of appellation of origin, that is the "geographical name of a country, region or locality which serves to designate a product originating therein, the quality and characteristics of which are due exclusively or essentially to the geographic environment, including natural and human factors". The competent authorities of contracting States can get such name registered by the International Bureau of WIPO in Geneva. The International Bureau communicates the registration to the other contracting States.

Locarno Agreement : The Locarno Agreement Establishing an International classification for industrial Design concluded in 1968 and then it was amended in 1979. The Agreement established a classification for industrial design. The classification consists of 32 classes and 223 subclasses. It also comprises an alphabetical list of goods with an indication of the classes and subclasses into which these goods fall. The agreement is open to States party to the Paris Convention. The competent authorities of the contracting states must indicate in the official documents reflecting the deposit or registration of industrial designs the appropriate symbols of the Classification. The Agreement created a Union with an Assembly. Every state member of the Union is also the member of the Assembly.

Madrid Agreement : The Madrid Agreement for the Repression of False or Deceptive Indications of Source on Goods, which was concluded in 1891, was revised at Washington in 1911, at the Hague in 1925, at London in 1934, at Lisbon in 1958 and at Stockholm in 1967. "According to the Agreement all goods bearing a false or deceptive indication of source, by which one of the contracting states, or a place situated therein, is directly or indirectly indicated as being, the country or place of origin, must be seized on importation, or such importation must be prohibited, or other actions and sanctions must be applied in connection with such importation."

The Agreement provides for the cases and the manner in which seizure may be requested and effected.

Nairobi Treaty : The Nairobi Treaty on the Protection of the Olympic symbol came into existence in 1981. The Treaty is open to any state member of WIPO, the Paris Union, the United Nations or any of the specialised agencies brought into relationship with the United Nations. All States which are party to the Treaty are under the obligation to protect the Olympic symbol - five interlaced rings - against use of commercial purposes without the authorisation of the International Olympic Committee. The Treaty also provides that, whenever a license fee is paid to the International Olympic Committee for its authorisation to use the Olympic symbol for commercial purposes, part of the revenue must go to the interested national Olympic Committee. India is a signatory to the Nairobi Treaty.

marks. The classification consists of 34 classes for goods and eight for services and an alphabetical list of some 11,000 items of goods and services. Countries party to the Nice Agreement are required to include in the official documents and publications concerning the registration of marks the numbers of the classes of the classification to which the goods or services for which the mark is registered belong.

North American Free Trade Agreement (NAFTA), is an agreement between three countries namely the USA, Canada and Mexico. The agreement came into force in January 1994 with the objective of harmonising the intellectual property rights in the member states by providing a framework for efficient utilisation of resources through trade liberalisation. The agreement has no provision for setting up of a common patent office or evolving guidelines for common filing of patent or granting of patents.

CD-based interactive IPR training package launched by NRDC

To have a competitive edge in the new global economic order, protection of one's intellectual wealth by incurring the least cost is the first priority. Onwards January 2005, the country will be obliged to fully implement the new WTO regulations on this account. It is with this broader scenario in mind that an interactive CD on IPR was targetted by National Research Development Corporation (NRDC), New Delhi in the larger national interest. This "Multimedia Interative Training Package on IPR" has been developed jointly by NRDC and Aesthetic Technologies, Calcutta with the support from Department of Scienctific and industrial Research (DSIR), Ministry of Science and Technology, Government of India under the Program Aimed at Technological Self Relaince (PATSER).

The CD-package was released on the occassion of Technology Day, the 11th May 2001, by Dr. Murli Manohar Joshi, Hon'ble Minister for Human Resource Development, Science & Technolgy and Ocean Development. On this occasion Shri Bachi Singh Rawat, Minister of State for Science and Technology, Prof. V.S. Ramamurthy, Secretary, DST, Dr. R.A. Mashelker, Secretary, DSIR and Dr. Manju Sharma, Secretary, DBT were also present.

CD Contents

* Introduction to IPR
* How does the IPR system work
* Various kinds of IPR
* Benefits of IPR
* What is not protected by IPR
* All about patents
* The entire patenting process
* Copyright and related rights
* Design registrations
* Trademarks
* Geographical indications
* Topography of integrated circuits
* Trade secretes
* IPR policy and management
* IPR in the following sectors:
  - Government & Nation
  - R&D organisations (National and industry sectors)
  - Information technology, Electronics and Media
  - Chemicals, Engineering, Construction and Services
  - Biotechnology, Drugs & Pharma and Agro processing
  - Individuals & Small Scale Industry

This multimedia training package will provide information on different kinds of intellectual property rights with more than 10,000 pages of information related to IPR videos, interviews with experts and lucid pictorial explanations of complex issues (see contents list).

This package helps individual scientists, scholars, corporates, inventors and innovators to understand a subject that had till now remained the domain of legal experts and patent attorneys. It explains each and every aspect of intellectual property. From broader classifications and categorizations it smoothly and conveniently makes the learner to move into its sub-categories and finer explanations at the user's will. It enlightens then on protecting their knowledge -based assets in the new economic order without spending extra money and time in attending seminars and training sessions to get familiarized with IPR jargon. The package costs only Rs. 20,000 (Twenty Thousand).

When we refer to our entry into a knowledge based society and economy, we must have in mind the knowledge that works, which is usuable for benefit of society. Every society and nation will have to encourage its people to generate more and more of this wealth. But no one will do it for free in today's commercial world. Incentives have to come. It was therefore, realised that the creator of such knowledge must be given some exclusive rights over the use of this knowledge for a specified period. This formed the genesis of intellectual property rights (IPR). After the monopoly holder reaps out his due dividend in the protected period, the right to this knowledge passes on to public domain.

The new package, the only of its kind in the country so far, shall be an asset for any big or small organisation having concern with R&D, inventions, innovations industrial designs, trade marks, creative writings, etc., in any manner. Because of these features it shall be self-compelling purchase for research laboratories, R&D Divisions of public and private sector companies, law schools, practitioners of patent, copyrights, trade marks & designs etc. Those who are interested to know more about it may contact : **NRDC, 20-22, Zamroodpur Community Centre, Kailash Colony Ext., New Delhi-110 048. E-mail: nrdc@nda.vsnl.net.in**

Contributed by: R. D. Rikhari, 14-E, Pocket-1, Mayur Vihar, Phase-I, Delhi-110 091.

Nice Agreement : The Nice Agreement concerning the International Classification of Goods and Services for the Purposes of the Registration of Marks concluded on June 15, 1957. The Agreement entered into force on April 8, 1961. This was subsequently revised at Stockholm in 1967 and then at Geneva in 1977. The agreement was amended in 1979. The Agreement which is open to the States party to the Paris Convention established a classification of goods and services for the purposes of registration of trademarks and service

Paris Convention : The Paris convention for the protection of Industrial property concluded in 1883, was completed by an Interpretative protocol in Madrid in 1891, was revised at Brussels in 1900, at Washington in 1911, at the Hague in 1925, at London in 1934, at Lisbon in 1958 and at Stockholm in 1967 and it was amended in 1979. The convention, which is open to all states, applies to industrial property in the widest sense including inventions, marks, industrial designs, utility models, trade names, geographical indication and the repression of unfair competitions.

Rome Convention : The Rome Convention for the protection of performers, producers of phonograms and an Broadcasting Organisation (1961), secures protection in performance of performers, (actors, singers, musicians dancers and other persons who perform literary or artistic works, phonograms of producers of phonograms and broadcasts of broadcasting organisation. The Rome Convention is open to States party to the Berne Convention or to the Universal Copyright Convention. The Convention is administered by WIPO jointly with the WTO and UNESCO. The convention has no provision for the institution of a Union or a budget. It has an intergovernmental committee composed of contracting states, that considers questions concerning the Convention.

Strasbourg Agreement : The Strasbourg Agreement concerning the International Patent Classification concluded in 1971 and it was amended in 1979. The Agreement established the International Patent Classification (IPC) which divides technology into eight sections with approximately 67,000 subdivisions. Each subdivision has a symbol consisting of Arabic numerals and letters of the Latin alphabet. The appropriate IPC symbols are indicated on each patent document. The appropriate symbols are allotted by the national or regional industrial property office that publish the patent document. Every year over 1,000,000 appropriate symbols are issued. The Agreement is open to States party to the Paris Convention.

Vienna Agreement : The Vienna Agreement establishing an International Classification of the figurative Elements of Marks concluded in 1973. The Agreement established a classification for marks which consists of or contain figurative elements. The classification consists of 29 categories, 144 divisions and 1,569 sections in which the figurative elements of marks are classified. The Agreement is open to States party to the Paris Convention. It is mandatory for the contracting States to indicate in the official documents and publication relating to registration and renewals of marks the appropriate symbols of the classification. Besides the member states the classification is used by the industrial property offices of some non-member states and as well as by the International Bureau of WIPO, the Benelux Trademark office and the office for Harmonization in the Internal Market (Trade Marks and Designs) of the European communities. The Agreement created a Union with an Assembly. Every State member of the Union is a member of the Assembly.

Union of Protection of Plant-Variation (UPOP) Convention : This was signed in 1961 and came into force in 1968. Subsequently the convention was revised in 1972, 1978 and 1991. The convention addresses the condition for entitlements to offer protection to a plant breeder of a new variety. A breeder will be entitled to such protection provided the varieties is distinctly different from the commonly known existing variety.

The Trademark Law Treaty was adopted on October 27, 1994 at a Diplomatic Conference in Geneva. Its purpose is to simplify and harmonise the administrative procedures in respect of national application and the protection of marks. The treaty does not deal with the substantive parts of trademark law covering the registration of marks. The Treaty contains no obligation for a contracting Party to be a party to other international Conventions. However, it provides in Article 15 that Contracting Parties must comply with the provisions in the Paris Convention which concern marks. The provisions of the Treaty are supplemented by the Regulations which provide rules concerning details useful in the implementation of the provisions on administrative requirements and procedures according to the Treaty. The Regulations also contain eight Model International Forms which concern the filling of an application, the requests for renewal, records of change in names, addresses and ownership, correction of mistakes, appointment of representative, certificates of transfer and transfer of document.

The European Patent Protection (EPC) came into force in 1973. It is administered from the European patent office in Munich. An applicant can file a single patent application with the European Patent office and obtain patent protection in one, several or all of the 19 contracting states. The patent application can be filed in any one of the three official languages viz. English, French and Germany. While a patent issued by EPC confers on the inventor the same rights as one entitled by a national patent granted in a designated State, but enforcement issues are dealt with by national courts individually. It may be noted that the decision of the court in one contracting state in not binding on the court of another contracting State.

The European Community Patent Convention : This was created by the members of the European Union on December 15, 1975. The main objective of the convention, which is called Community Patent Convention (CPC), is to eliminate post-grant limitations of the EPC system.

The African Intellectual Property Organisation (ARIPO): This was created under the Lusaka Agreement on December 7, 1976. It consists of the English speaking African nations. The ARIPO is mainly concerned with pre-patent grant proceedings on behalf of the Member States. Once the patent is granted it comes under the jurisdiction of the national laws of each of the Member States.

The Patent Cooperation Treaty (PCT) came into force on January 14, 1978. It became operational with 18 contracting States on June 1, 1978. The Treaty seeks to simplify the filing and processing of patent application worldwide. In fact it is part of an ongoing international attempt of WIPO to rationalise and facilitate the process of obtaining patent. It is often described as being the most significant advance in international cooperation in this field since the adoption of the Paris convention itself. PCT does not grant patent. It facilitates obtaining national patents in several countries. It consists of two phases - an international phase and a national phase. The international phase consists of a centralised filing and searching procedure (PCT Chapter I) and optional international primarily examination (PCT Chapter II). The national phase concerns with the final patent granting procedure before the national or regional industrial property offices. The filing of only one international application has the same effect as if separate national or regional applications had been filed in all the countries which the applicant designated in his international application. PCT becomes relevant only when one is interested in filing patent applications in several countries. As on March 23, 2000 there were 108 contracting states party to the PCT. India joined the PCT with effect from December 7, 1998.

The Hague Agreement Concerning the International Deposit of Industrial Designs was adopted within the framework of Paris convention on November 6, 1925. The Agreement entered into force on June 1, 1928. Subsequently it has been revised on a number of occasions. Its main aim is to enable protection to be obtained for one or more industrial designs in a number of States through a single deposit filed with the International Bureau of WIPO. An international deposit does not require any prior national deposit. It is made directly with the International Bureau of WIPO by the depositor or his representative on a form provided free of charge by the International Bureau.

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