

Feature

Science and Technology

Time Dilation in the Theory of Relativity

by Mohd Anisur Rahman

TIME can be rightly said as the oldest witness of all the happenings in this universe. The 'Old Gypsy Man' is ticking away to glory since the birth of the universe and will continue until the end. Ever since its 'birth' it seems to have submitted to just one duty that is to march forward towards an uncertain future mercilessly thrashing the present down into the realm of unobtainable past.

Although it is practically impossible to stop time from this relentless journey no matter how hard we try, Einstein, in his revolutionary work, the Theory of Relativity, has shown us how this impossible could be made possible, at least theoretically, by introducing the concept of Time Dilation.

Before we come down to a formal definition of time dilation it is worthwhile to have a look at the terms like — proper frame of reference, proper and improper time interval. In relativity, proper frame of reference is that frame in which the observed body is at rest. Suppose a passenger in a train (travelling at a constant speed) is enjoying a cup of coffee in the pantry car. With respect to the train or any other train travelling at the same speed in the same direction on a parallel track, this passenger is at rest. So any train's frame of reference in the above could be located as proper. Now, proper time interval is the interval recorded by a clock attached to the body observed. If the passenger wishes to know the time interval in finishing the cup of coffee, he had better rely on his own clock or the train's clock which is at rest with respect to him.

Excepting these, any other observer's recorded time according to their respective clocks would be different times of the same event — which can be termed as improper times. Naturally we

would expect an observer sitting at the station to record a different time than the passenger. But this kind of disparity is not noticed in our practical life since speeds associated with each clock and thereby the frame of reference are too low. Low speeds hardly

formula that even if our rockets achieve a speed of 300 meter per sec, quite high compared to the standard achieved so far, improper time interval is negligibly different from proper time. But when high speeds are involved, for example when the speed of the ob-

This could be illustrated with a rather beautiful example. If a astronaut flies off our good old earth at four-fifth speed of light, it takes about 24 years of space travel according to his clock, he will come back to find his 'staying-on-earth' friends record 40 years meanwhile according to their earthly clock. Let's hope he doesn't end up marrying his girl friend's daughter then!

It is rather intriguing that biological effects should show up just as well as the instrumental clocks. But Einstein has clearly implied this is indeed possible. His famous 'Twin Paradox' or the clock paradox is part of the show. In this Einstein specifically predicted that.

"If we placed a living organism in a box... one could arrange that the organism, after any arbitrary lengthy flight, could be returned to its original spot in a scarcely altered condition, while corresponding organisms which had remained in their original positions had already long since given way to new generations. For the moving organism the lengthy time of the journey was a mere instant, provided the motion took place with approximately the speed of light."

If we think the stationary organism is a man and his travelling twin, then the travelling twin would find his twin brother much more aged upon returning home. The disparity of their ages would depend upon how close to the



make any difference, and that could be seen in the formula relating time dilation in any book on Relativity. It can be inferred from the

served body is four-fifths of that of light then proper time interval is three-fifths of improper time interval, the effect becomes substantial.

Space Shuttle Lifts Off to Begin Long Science Flight

THE US space shuttle Columbia has rocketed into space on a two-week science mission that includes experiments that could spawn improvements in areas ranging from computers to jet engines.

Columbia and its five astronauts lifted off at 1353 GMT March 4 from Kennedy Space Center in Florida loaded with more engineering and technology experiments than ever flown on the shuttle before.

The liftoff was delayed one day because of high wind at the launch site. The shuttle is scheduled to spend 13 days and 23 hours in orbit, just one hour short of the longest shuttle flight ever, which was flown by Columbia last October.

Columbia is carrying a special structure called the US Microgravity Payload, which supports five experiments that will study semiconductors and the behavior and properties of metals as they melt and re-solidify. Another group of six experiments, called the In-Space

Technology Programme, will collect data for use in building future advanced satellites and the planned space station.

The crew, four men and one woman, will also occupy themselves with a barrage of medical tests and protein crystal growth experiments that could lead to new drug treatments.

Astronaut Marsha Ivins, on her third space flight, told reporters prior to liftoff that Columbia's research mission is less flashy but more practical than the past two shuttle missions, which featured the capture and repair of the Hubble Space Telescope and the first shuttle flight of a Russian cosmonaut.

"If we can figure out how to make a better material so that a structure is stronger and lighter and lasts longer and weathers better, or we can come back ultimately with something that leads to a cure for cancer or AIDS or any other disease, I would say

that's pretty practical," Ivins said.

Shuttle commander John Casper said the Columbia flight should be seen as a precursor to the space station.

"The experiments and research we're going to be doing on this flight are very similar to what we'll be flying on the space station," he said. "So when we get to the space station, we'll better be able to operate."

One of the experiments aboard Columbia will study the production of semiconductors in space, research that could benefit the computer industry by allowing development of faster information processing systems.

Another experiment will study the formation of dendrites, the tiny geometric structures that determine the basic strength, flexibility and hardness of most metals. This could lead to stronger alloys for future cars and jet airplanes.

On Earth the effects of gravity can be so strong that they can hide what we are trying to study," said mission scientist Peter Curreri. "However, in microgravity, what nature is really doing can become quite clear."

Still another experiment is aimed at understanding something called the "critical point phenomenon" — a combination of circumstances that enables certain fluids to exist both as a liquid and a gas at the same time. This phenomenon might be used commercially for such purposes as removing caffeine from coffee, using water at its critical point instead of relying, as some producers do, on treatment with methylene chloride, a potential carcinogen.

Many of the major experiments aboard Columbia will be remotely monitored and operated by scientists on the ground. Through a technique called "telepresence," researchers will be able to analyze their data and adjust their experiments as necessary during the mission to take maximum advantage of the limited research time in orbit.

Columbia's cargo also includes 12 rats to be used to study bone growth in space. Each rat received a drug before the flight began designed to stimulate bone growth. Researchers want to see if the drug helps prevent bones from weakening in weightlessness, a common problem suffered by astronauts during space flight. — USIS



The booster with Soyuz TM-9 spaceship in pre-launch position at the Baikonur cosmodrome, Kazakhstan on February 10, 1990.

Fuel Mixture of N. Fusion

SCIENTISTS at Princeton University used a new fuel mixture to produce the most powerful nuclear fusion reaction ever achieved in a laboratory, raising prospects for abundant and cheap electrical power in the future.

An experimental 15-meter-high reactor at Princeton Plasma Physics Laboratory in Princeton, New Jersey, produced a world-record-setting burst of fusion energy equivalent to three million watts of power December 10.

Although the burst of energy lasted only four seconds and the reactor consumed about eight times as much energy as it produced, they yield was the best that any fusion reactor has yet achieved.

The power output of the latest experiment was nearly double the 1.7 million watts produced two years ago by the Joint European Torus, or JET in Abingdon, England, the Princeton groups chief rival.

"We're on our way to achieving the goals of fusion power," said Dale Meade, deputy director of the Princeton laboratory, which is funded by the US Department of Energy.

The Princeton researchers achieved the latest milestone by firing up their test reactor with a fuel mixture that had never before been used in such high concentrations: a 50-50 mixture of deuterium, a heavy isotope of hydrogen, and another hydrogen isotope called tritium, a radioactive gas used in thermonuclear warheads. Most previous research in fusion power has used only deuterium. The European Torus ran the

first ever fusion experiment using a plasma fuel containing tritium two years ago. But the tritium content in that experiment made up only about 10 per cent of the deuterium-tritium mixture. The 50-50 mixture used at Princeton produced far more power.

The Princeton group expects to increase the power of its reactor to 10 million watts over the next nine months, an output 100 million times higher than early fusion reactors achieved in the 1950s. The reactor can produce this level of energy only in brief bursts, because it would take far too much energy to keep the fusion reaction going longer.

No fusion reactor has yet come close to producing more power than it takes to run the machine.

If all goes well during the planned tests at Princeton, and if Congress makes a long-term commitment to continue funding fusion research, scientists believe a commercial fusion power plant could be operating by the year 2035.

Although the Princeton test reactor operates in pulses that last only seconds, a fusion power plant would presumably ignite fuel in a sustained fusion reaction and produce far more electric power than it consumes.

"We ourselves may not live to see a commercial fusion reactor in operation," Meade said. "But we have a chance of leaving fusion energy technology of our grandchildren."

Fusion, the same process that powers the sun, is a reac-

tion in which the nuclei of hydrogen atoms are forced to merge. The single protons from each nucleus join to produce helium, with two protons in its nucleus. The fusion rearrangement releases one leftover neutron and a great deal of energy that eventually might be harnessed to produce electrical power.

A fusion reaction is the opposite of fission, which involves breaking apart very heavy atoms, such as uranium. Fission is the process used by current nuclear power plants.

Scientists have long hoped that the fusion process, depending on an inexhaustible supply of hydrogen atoms and creating no hazardous waste, could eventually replace nuclear fission plants that produce large amounts of radioactive waste.

In the reactor used by the Princeton group, known as the Tokamak Fusion Test Reactor, the mixture of deuterium and tritium gas is stripped of its electrons by heat so that each atom acquires a positive electric charge. In this form the gas is called a plasma. Powerful interlocking magnetic fields are then used to confine and compress the electrically charged plasma at high enough temperatures to induce fusion.

The design of the doughnut-shaped Tokamak was pioneered during the 1950s by Russian physicists Andrei Sakharov and Igor Tamm.

The Princeton reactor cost about \$1,400 million to build, and is allocated about \$110 million annually in the US budget for fusion research.

The Effects of Solar Ultraviolet Radiation on the Eye

A new International Research Programme on Health, Solar UV Radiation and Environmental Change (INTERSUN) is under consideration by the International Agency on Cancer (IARC), the World Health Organisation (WHO) and the United Nations Environment Programme (UNEP). This comes as a direct consequence of the United Nations Conference on Environment and Development, held last year in Brazil.

In Agenda 21, adopted in Rio de Janeiro, it was specifically recommended to "undertake, as a matter of emergency, research on the effects on human health of the increasing ultraviolet radiation reaching the earth's surface as the consequence of depletion of the stratospheric ozone layer".

There is already convincing evidence that ultraviolet radiation is related to several types of skin cancers, including the potentially fatal melanoma. Sufficient animal and human data also exist to relate consistent UV radiation exposure to increased incidence of certain types of cataract. In view of the fact that half of the 35 million cases of blindness in the world are due to unoperated cataract, it is important and urgent to verify whether the sun, through its ultraviolet radiation, is responsible for the blindness of millions of people.

In order to develop a programme of activities in this field at the global level, a Consultation on the effects of UV radiation on the eye is meeting in Geneva from 30 August to 3

September 1993. It is jointly organized by the two most concerned WHO technical units: the Unit for the Prevention of Environmental Pollution, which is part of the Division of Environmental Health, and the Programme for Prevention of Blindness, which is part of the Division of Health Protection and Promotion.

International collaborative study on cataract

Specialists from twelve countries are expected to review scientific knowledge on the effects of solar ultraviolet radiation on the eye and particularly on the development of cataract. Together with participants from other United Nations agencies such as IARC, UNEP and the World Meteorological Organization (WMO), they will propose to launch an international collaborative study on the relationship between cataract and solar radiation exposure. They will also try to identify ways to mobilize the resources needed for these research activities.

The main objectives of the study will be to describe accurately the relationship between ground level solar ultraviolet irradiance and incidence of cataracts in defined populations, and to increase understanding of the relationship between personal risk of cataract and constitutional sensitivity to the sun and sun-related behaviour.

The new study should give a clearer insight into this increasing problem. — WHO

An Introduction to Economic and Efficient Machining

by Dr Mohammad Sayeedul Haq

THE traditional manufacturing processes referred to as machining are used for production of goods. In these processes, parts of specified dimensions are produced and finish by removing chips (the excess material) with cutting tools. The process economy and the profitability in metal removing operations are primarily linked inter alia to the following factors:

The Workpiece

The physical, metallurgical, and other properties of the workpiece should be carefully studied and evaluated in order to determine, among other things, the type of machine tools to be used including their horsepower rating. For example, the machining of an automobile cylinder block requires relatively less machining forces than that of a rugged workpiece. Another important area is the machinability of the basic engineering materials. Based on requirements, the machinability rate of plain steel can be increased to more than 600 sfm by adding prescribed amount of lead and tellurium with the steel. Free-machining steels have high machinability rate due to their high sulphur content.

The Cutting Tools

The effectiveness of cutting tools, tool life, tool change time, etc, have direct bearings on the process economy. The types of tool available in the market; their holders, inserts, and bits; pertinent assembly devices and methods; etc, are crucial to the proper selection of cutting tools. The commercially available tool bits, like the throw-away type of high-speed-steel tool bits used in machining applications have considerably reduced machine downtime and eliminated tool reconditioning.

Workpiece Holding Devices

To ensure the quality of a product, the workpiece must be held properly to withstand the cutting forces during machining. The milling methods by which the cutting forces are generated, the nature and magnitude of cutting forces, etc, should be considered while devising the holding method. It should be noted here that down milling is normally specified as cost saving method when requirements like better finishes, close tolerances are crucial. The workpieces are generally held by devices like pneumatic vise, magnetic chuck, hydraulic holding devices, etc. Electrostatic devices are used when other holding techniques are either more costly or non usable.

Machine Tool Controls

Besides electric and mechanical controls, cybernation ranks high in the list of control sophistication. Numerically Controlled Drill Press, Numerically Controlled Machining Centre, Numerically Control Turret Lathe, etc, are machine tools equipped with numerical controls (N/Cs). The application of the N/C has considerably reduced set up time, change over time, and the size of working-in-progress inventory; and ensured the required level of product quality. Another type of control is photoelectric control. The Photoelectric-Controlled Band Saw Machine uses an electrohydraulic servo system.

The Machine Tool

The configuration of the machine tool is dependent on several factors and limitations like job specification, cutting tool, workpiece materials, fixture, economy, etc. A wide variety of machine tools is available for various machining applications. While selecting a machine tool, the following considera-

tions should inter alia be given to achieve higher productivity:

- (i) the machine must be able to perform required job satisfactorily.
- (ii) the machine must be able to perform other machining jobs without major modifications. In this connection, it may be mentioned that machine tool accessories give required flexibility to a large extent.

The development of machining centre has brought some distinctive advantages to traditional manufacturing process by improving its competitiveness relative to zero-force machining and other techniques.

Pilot Lands in Record Books



BRITISH flyer, Barbara Harmer, 39, who has become the first woman to pilot Concorde, pictured standing under the nose of the supersonic civil aircraft on the apron at London's Heathrow Airport. The British Airways (BA) pilot from Bognor Regis, southern England, recently flew Concorde on a commercial

flight from London to New York, after special training for six months. One of 40 female pilots with BA, she was previously flying long-haul DC10s. Concorde, the product of Anglo-French partnership, is the world's only supersonic civilian airliner. British Airways has seven in operation providing flights

throughout the world. Their ability to cruise at twice the speed of sound — faster than some rifle bullets — means it takes an average of only three hours 25 minutes to fly the 3660 miles (5890 km) between London and New York, compared with nearly eight hours by subsonic aircraft. — LPS

Bacteria to Clean Up Oil Spills

USING bacteria to clean up oil spills can work, and there are scientific ways to measure its success, researchers reported on Thursday, says Reuter.

Oil-eating bacteria were used experimentally after the 1989 Exxon Valdez oil spill, which dumped 11 million gallons (50 million litres) of oil into Pristine waters off Alaska.

It polluted more than 1,200 miles (2,000 km) of coastline and killed thousands of birds and marine mammals.

The Exxon oil company used what are called bioremediation techniques to clean up residue. The procedure involves adding fertilisers to enhance the growth of bacteria that can naturally degrade some of the toxic hydrocarbons in crude oil.

In a report in the science journal Nature, James Bragg of the Exxon production research company in Houston said his team had found ways to measure how well the technique worked. "We demonstrate that measuring changes over time in the oil composition relative to a stable, high-molecular-weight hydrocarbon present in the oil when spilled allows

quantification of the rate and extent of the oil biodegradation with high levels of statistical confidence," they wrote.

"For the Exxon Valdez oil, we found that Hopane, a multi-ring saturated hydrocarbon, was not biodegraded and was a good conserved standard."

Between 44 and 99 per cent of hydrocarbons in the oil were broken down, with results visible within two weeks, they said.

But they said there were limitations to the new approach.

"Bioremediation is not likely to be effective on extensively degraded oil further, adequate oxygen must be available, bioremediation within anaerobic fine sediments such as mud flats or marshes would probably be effective only at shallow depths."

Richard Swannell of the National Environment Technology Centre at Harwell, Central England, said the findings would allow the continued use of biological remedies. "With the compelling evidence now described (in this study), this technique for the treatment of oil spills has finally come of age" he wrote in a commentary in Nature.