Union Government, conducting a national seminar on the outreach concept successfully inviting highly reputed academicians, including the former UGC Vice-Chairman, Director, NAAC, a few former Vice-Chancellors, personnel from the industries, NGOs, etc. Does this reflect anything on our system or people? With this kind of approach, can any reform take place from within in an effective way? Would any Vice-Chancellor like to get into unnecessary trouble by starting new initiatives in the University? Even if one wants to take some bold steps, will he/she be able to give them full shape within a short term of 3–4 years? With these kinds of happenings in the university system, Balaram's question of 'can anything be done' is thought-provoking.

In the past few years, many countries have witnessed significant transformations and reforms in their tertiary education systems, including the emergence of new types of institutions, changes in patterns of financing and governance, establishment of evaluation and accreditation mechanisms, curriculum reforms and technological innovations. In India also, some universities when headed by a dynamic and visionary Vice-Chancellor, have introduced some reforms and restructuring in the system, which has been later opposed or nullified. Our governments and the university authorities and academics should not forget that India has a great chance of becoming a global leader in the knowledge economy and it is in their hands to make this happen. We should not forget the objective of each of our activities (as mentioned in the case of meetings by Raman quoted above[3]) and we should work towards it with a purpose.

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On the resolutions of the twin paradox

Lorentz transformation equations (LTEs) predict that if an electric dipole stationary in the free space oscillates n times/s, then the same dipole must oscillate $n \times \sqrt{1 - u^2/c^2}$ times/s when it moves with a velocity u in the direction perpendicular to the direction of oscillation of the dipole. Curiously, the same equations also predict that even if the dipole is at rest in free space and the measuring apparatus moves with the same but opposite velocity, then also the apparatus will record that the dipole is oscillating $n \times \sqrt{1 - u^2/c^2}$ times/s. Classical physics of electrodynamical phenomena does not accept this.

Albert Einstein was in favour of the LTEs and thereby tried to justify their reality by his well-known principles (assumptions) which constitute the special theory of relativity (STR). Instead of classical time independent of coordinates, it uses relative time as a function of coordinates and imports equivalent observers to make the frequency-shift phenomenon (derived from LTEs in both ways) intelligible from its novel setting.

Abolition of both the preferential observer in free space and classical absolute time makes it difficult to settle the real time in the clock of each equivalent observer. The constancy of the speed of light to all equivalent observers further complicates the situation.

Though overlooked, relative time struggles hard to survive at the noose of many alien concepts in spite of measures of symmetry adopted by its originator. This is evident in the twin paradox. The paradox centres on the problem of time in case when a man and his twin have a steady relative motion. From the consideration of STR, each twin would claim that the other's clock runs slow compared to the synchronized clock in his own frame.

Unnikrishnan's arguments[1] suggest that the resolution of the twin paradox as presented by the relativists is devoid of any rationality. He is in favour of the rejection of the STR, which is however not unique. Many others also equally share the same conviction with Unnikrishnan.

Grøn[2] has tried to counter Unnikrishnan with the consideration of the STR. But, unfortunately, he has evaded the central question relating to the problem.

We may now clarify here the central question of the twin paradox in the following simple examples.

(a) The STR predicts that the lifespan of radioactive particles increases with velocity, which has been verified by experiments when the observer with his measuring apparatus is at rest on the surface of the earth and the radioactive particles moves with respect to it. To establish the validity of the STR, Grøn has to show that similar results are confirmed by experiments when the radioactive particles are stationary while the observer with his measuring apparatus steadily moves. In the absence of such a clear-cut experiment, Grøn's analysis is meaningless.

(b) Similarly, the STR predicts transverse Doppler effect (time-dilation effect) for steadily moving radiating dipoles. To establish the validity of the STR, similar results should be confirmed by experiments when the radiating dipoles are at rest on earth, while the observer moves steadily.

We expect that experiments with latest techniques will not detect any of these phenomena when the radiating dipoles are at rest on earth, while the observer with his measuring apparatus moves.

However, we maintain that physics should be based on the available experimental data and not on data which could never be verified, nor on data which are expected to be verified later. Therefore, Grøn's discussion is a matter of philosophy, not of physics.

'Time dilation' could easily be explained from classical electrodynamics as the natural increment of the period of an electromagnetic event due to motion, time remaining the same to all observers according to classical physics. The gist of this explanation is given below.

When a radiating electric dipole moves steadily on earth, the electric and the induced magnetic fields inside the dipole change according to the classical electrodynamics of Heaviside and, thereby, all electrodynamic phenomena inside the steadily moving dipole also change, which at once destroys the relativistic time-dilation concept.

Heaviside[3] deduced classically the electric field ($\boldsymbol{E}$) and the induced magnetic field ($\boldsymbol{B}^*$) of a point charge (Q) at a point $P(r, \theta, \phi)$ when the charge passes through the origin towards OX with a velocity $\boldsymbol{u}$ in free space, as under:

$$\boldsymbol{E} = \frac{Qk^2\boldsymbol{r}}{4\pi\varepsilon_0 r^3[1-(u^2/c^2)\sin^2\theta]^{3/2}},$$

$$(k = \sqrt{1-u^2/c^2}), \tag{1}$$

$$\boldsymbol{B}^* = (\boldsymbol{u}\times\boldsymbol{E})/c^2, \tag{2}$$

where ε_0 and μ_0 are the permittivity and permeability of free space, and $c = 1/\sqrt{\mu_0\varepsilon_0}$.

Relativists should note that the vital equations (1) and (2) were deduced first not by Albert Einstein from relativity as often tacitly claimed, but by Heaviside from the consideration of classical physics in 1888.

Electromagnetic momentum ($\boldsymbol{P}$) and the magnetic energy (T) of a steadily moving point charge could then be written as

$$\boldsymbol{P} = \int_{\text{all space}} (\boldsymbol{D}\times\boldsymbol{B}^*)\,\mathrm{d}v$$

and

$$T = \frac{\varepsilon_0 c^2}{2}\int_{\text{all space}} \mathbf{B}^{*2}\,\mathrm{d}v,$$

where $\boldsymbol{D}$ and $\boldsymbol{B}^*$ are the electric induction vector and induced magnetic field vector respectively, and dv is the infinitesimal volume element in free space.

Using $\boldsymbol{B}^* = (\boldsymbol{u}\times\boldsymbol{E})/c^2$, we have $P = 2T/u$.

Now we have from classical electrodynamics[4],

$$T = Q^2u^2/(12\pi\varepsilon_0 c^2 k\delta R),$$

where δR is the radius of the point charge.

Therefore, in vector notation we have for the steadily moving point charge,

$$\boldsymbol{P} = Q^2\boldsymbol{u}/(6\pi\varepsilon_0 c^2 k\,\delta R). \tag{3}$$

The electromagnetic force acting on a point charge moving steadily in free space in a direction perpendicular to the direction of the uniform electric field operating in free space is given by:

$$F_\perp = (|P|/|u|)a_\perp = (m_0/k)a_\perp$$

$$= \gamma m_0 a_\perp = m a_\perp, \tag{4}$$

where $Q^2/(6\pi\varepsilon_0 c^2\delta R) = m_0$ and $\gamma = 1/k$. $a_\perp$ is the acceleration of the point charge in the direction perpendicular to u. This implies that from the consideration of classical electrodynamics, the transverse electromagnetic mass of charges varies with velocity.

Now using the above four equations, we shall prove the velocity-dependence of frequency and period of oscillations of an electric dipole, classically.

Let an electric force $\boldsymbol{F}_0$ (originating from a small charge inside the dipole) drive a point charge back and forth in a radiating dipole stationary on the surface of the earth. Then from classical electrodynamics,

$$\boldsymbol{F}_0 = -m_0\omega_0^2\boldsymbol{S}, \tag{5}$$

when the velocity of oscillation is small (m_0 is the electromagnetic mass of the charge in the stationary dipole, ω_0 the radian frequency of oscillation of the charge, and $\boldsymbol{S}$ the separating distance of the dipole).

Now, if the above dipole and the source of the field which excites the dipole are moving together with a velocity u on the earth in any direction perpendicular to its direction of oscillation, the electric force and the magnetic force acting on the point charge will be respectively, from eqs (1) and (2), (when $\theta = 90°$), $\gamma\boldsymbol{F}_0$ and $-(u^2/c^2)\gamma\boldsymbol{F}_0$. Therefore, the total electromagnetic force acting on the moving point charge is

$$\boldsymbol{F} = \gamma\boldsymbol{F}_0 - (u^2/c^2)\gamma\boldsymbol{F}_0 = \boldsymbol{F}_0 k, \tag{6}$$

and eq. (5) is modified to,

$$\boldsymbol{F} = -m\omega^2\boldsymbol{S}, \tag{7}$$

where $m(m_0/k = m)$ is the electromagnetic mass, ω the frequency of oscillation, and $\boldsymbol{F}$ the electromagnetic force acting on the charge moving with a velocity u.

From eqs (4)–(7) for the dipole moving with an uniform velocity on the earth in any direction perpendicular to its direction of oscillation we have,

$$\omega = \omega_0 k. \tag{8}$$

This explains transverse Doppler effect from classical physics.

The relation for the stationary dipole is

$$t_0 = 2\pi/\omega_0, \tag{9}$$

where t_0 is the period of oscillation and ω_0 the radian frequency modified for the moving dipole to

$$t = 2\pi/\omega, \tag{10}$$

Comparing eqs (9) and (10) with the eq. (8) we have,

$$t = \gamma t_0. \tag{11}$$

Equations (8) and (11) show that the frequency of oscillation of the moving radiating dipole decreases and that the period of oscillation of a moving electric dipole increases with its velocity on earth.

This at once destroys the 'here is one time', 'there is another time' concept, as well as the twin paradox of relativity.

In this classical approach, there will be no transverse Doppler effect when the radiating dipole is at rest on earth, while the observer with his measuring apparatus moves transversely to the dipole in the opposite direction.

In the light of this discussion, empirically unsupported analysis as in Grøn[2] is meaningless.

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Response:

The reason I did not write a comment on Grøn's[1] remarks earlier was the obvious inconsistency and lack of logical integrity evident in his remarks as reflected in the final paragraph, which asserted that most existing analyses of twin paradox are indeed correct. As pointed out in my