Lorentz-Horses and Maxwell-Flexures on Laputa

Sadanand S. Savarkar
18, Walchand Terraces, Mumbai 400034, INDIA
e-mail: sssavarkar@gmail.com

Inquiries into the Gulliveresque velocity-modifications, on the flying island Laputa, of the strengths of the draught-horses, and the elastic properties of solids, necessary for the validity of relativity. The velocity-modifications uniquely demanded by relativity in one experimental situation are then found to result in conflicts with relativity in other experimental situations. Such conflicts in the elastic flexures of beams, unless credibly resolved, could provide means for the self-determination of the absolute motion of Laputa from purely internal experimental procedures, and thus present yet other Posers for the relativity theorists.

1. Introduction

The following is by way a commentary upon some of Newton's Posers in the author's science-play *The Catherine Conspiracy, or The Honest Relativity*. There, inspired by the wonders of *Gulliver's Travels*, Newton and his circle – his niece Catherine Barton, the astronomer Edmond Halley, and the mathematician Abraham De Moivre – construct in front of us the whole of the Relativity Theory by shooting rotating shells and harnessing draught-horses to simple Archimedean machines.

In Jonathan Swift's *Gulliver's Travels*, which was essentially a social and political satire, Gulliver visits the countries of Lilliput and Brobdingnag, and reports that in Lilliput the dimensions of every object are smaller by a factor of twelve, while in Brobdingnag they are larger by a factor of twelve. And yet for the residents of those two countries all affairs follow exactly the same courses as they do in England. Gulliver attributes this to the principle of 'relativity of scale' by observing, "Undoubtedly the philosophers are in the Right when they tell us that nothing is great or little otherwise than by comparison".

In the author's science-play *The Catherine Conspiracy: or The Honest Relativity*, Swift's political opponents dismiss the whole work as ridiculous and impossible by appealing to Galileo's demonstration of the impossibility of the 'relativity of scale'. Galileo's argument was: "If the dimensions of a horse were increased by a factor of four, his weight will increase by a factor of sixty-four, while the sectional area of his leg-bones will increase only by a factor of sixteen, and the horse would not be able to stand up on his legs."

In desperation Swift approaches Newton as the one man who could possibly answer Galileo's objection. Newton and his circle - Newton's niece Catherine Barton, the astronomer Edmond Halley, and the mathematician Abraham De Moivre – show that such a Gulliveresque 'relativity of scale' need not be altogether impossible. Catherine suggests that the difficulty could vanish if, along with the change of scale, the strength of the leg-bones of the horse in Brobdingnag were to increase by a factor of twelve. However, it is soon apparent that merely the change of the strength of the leg-bones would not be sufficient to ensure 'relativity of scale'; every property of every physical system must get modified suitably. Further, these geographic, or locality modifications must be coordinated in a conspiratorial manner.

Gulliver also visits the flying island Laputa during his stay in the country Balinbari, and reports that those traveling aboard Laputa are not in the least aware of their uniform motion. Newton remarks that if the 'activity' – as energy is designated in *Principia* – were physical, as it could well be since it is conserved - activity equaling counter-activity-, then the Laputan 'relativity of uniform motion' could also involve many mysteries.

If the energy possesses physicality, as Newton speculates and envisages, and has now been ascertained by experience, there could indeed be some weird consequences. Halley has an epiphanic revelation that as he rides at ease in his coach power of thousands of horses could be coursing through his body without his being aware of it.

2. Halley's Perplexity

It follows from the 'law of power' that when Halley presses his feet upon the front board – and applies a force -, the motion of the coach must result in work being done by Halley's feet. Halley's feet must therefore continuously transfer energy to the coach.

The back of the seat would be exerting a force upon Halley's back – as a reaction to the force exerted by Halley while reclining against it -, and, as a result of the motion of the coach, a continuous current of energy must flow into Halley through his back. Thus a continuous current of energy, equal to $\mathbf{v}\cdot\mathbf{F}$ per second, would be circulating through the body of Halley even if the motion of the coach were at a uniform velocity.

Halley's perplexity was that this circulation of energy could at times be of enormous proportions, while he was not aware of doing any 'work', or of any power constantly coursing through him. That this power could be of truly enormous proportions can be readily seen. What is $\mathbf{v}$ in the above concept of work being done? According to Newton's precepts, and his exhortation in Principia to avoid "the defilement of mathematical and philosophical truths", it is to be the absolute velocity, or the motion with respect to the Absolute Space.

If we assume the Sun to be at absolute rest, and if the coach were aligned along the motion of the Earth in its orbit, $\mathbf{v}$ could be of the order of 30 Km per second even if the coach were standing at rest on the ground. The motion of the coach relative to the ground would in fact be of negligible significance here. If Halley were exerting a moderate pressure of only 20 pounds-weight on the front board, the rate at which he does work – and imparts energy to the coach -, would equal approximately 'the power of 4,000 horses' ! And, if we take the absolute velocity to be of the order of 300 Km/sec - as determined from the observations of the Cosmic Microwave Background Radiation anisotropy-, then this power could equal 40,000 HP, or about 30 MW !

Halley's perplexity certainly merits a resolution, and must necessarily have significant implications for the relativity theories. Newton shows that Halley's perplexity could also possibly be resolved on Gulliveresque lines with a conspiracy of physical laws and coordinated velocity-modifications of physical systems so that the effects of motion are not noticeable in a uniformly moving system, such as the flying island Laputa in *Gulliver's Travels*.

Newton and his circle then construct in front of us a Gulliveresque theory for relativity of uniform motion on Laputa – the Lorentz theory, or the special relativity theory -, by shooting rotating shells and harnessing draught-horses to the simple Archimedean machines. Given the uniformities of space and time – the isotropy and homogeneity of Space and the ubiquitous even flow of Time -, apart from a single constant to be fixed from the empirical experience, the theory is determined uniquely by the requirement of 'relativity' alone. *No additional hypothesis is necessary about the velocity of light, demonstrating therewith the redundancy of Einstein's second postulate.*

The development does not, in fact, involve light, or electromagnetism, or any signals, or any considerations of clock-synchronisation, or simultaneity – the 'red herrings' that have been deployed for distracting attention from the significant factors, and therewith confusing and confounding conceptually simple physical situations. As said by the present author elsewhere, "Even a race of blind but intelligent physicists, without ever having experienced light, or known of electromagnetism, could also have come upon the Lorentz theory – or special relativity theory – as a possibility from mechanical considerations and experiments."

3. God's Good Ground

It has been demonstrated exhaustively and conclusively in the present author's popular science book *The Great Einstein-Sky-Ride* that the Newtonian Arena of Action constituted by absolute space and absolute time is imperative and undeniable. The arguments have also been set forth in essence in the author's paper, 'No Cloud-Cuckoo-Lands Any More: The Nature Works On The Absolute Ground' (Journal of New Energy, 2003), with the following line of reasoning:

The existence of an entity is undeniable so long as any Existence Theorem in respect of that entity stands unrefuted. Newton proved an Existence Theorem for the absolute space. All attempts, including the one by Einstein, to overthrow that Existence Theorem of Newton have failed.

The author has given another independent Existence Theorem in his above book, and some more in his subsequent writings. The overthrow of any of them has not even been attempted. Therefore, the existence of the absolute space is undeniable.

Unless and until each of such Existence Theorems is overthrown, the Newtonian Arena of Action is necessary, imperative, and obligatory for Natural Philosophy.

The relativity theories do not warp the Space or the Time, as preached by pseudo-philosophies; but they warped the understanding and the judgment of multitudes of authors.

All further descriptions and analyses shall be in the context of the Newtonian Arena of Action – God's Good Ground.

4. The Sensoriumn Modifications

Newton observes that the actual perception is the joint product of the raw reality and the individual sensorium – which includes the observational instruments. While the true reality – the absolute measures - will be perceived by the Sensorium of God, the human perceptions would be modified by the distortions suffered by the human sensorium, and it need not be altogether impossible – that is to say, not logically impossible – that a current of energy, even with energy having substantial and dynamical attributes, could flow through a moving individual without his becoming conscious of it, if the motion modifies his sensorium suitably.

Just as the 'relativity of scale' could be possible in Lilliput and Brobdingnag through 'locality-modifications' of the physical systems, similarly, given the suitable 'velocity-modifications' of physical systems, a 'Gulliveresque relativity' of uniform motion need not be altogether impossible for the flying island Laputa.

Since each inertial state is ontologically distinguished from the other inertial states by its own particular velocity with respect to the absolute space, there is no logical necessity that all inertial states are physically equivalent. There can be no logical objections to velocity modifying physical systems. Such velocity-modifications are in fact to be expected.

A conspiratorial scheme of the velocity-modifications and the laws of physics to ensure 'relativity of uniform motion' for Laputa is then the Gulliveresque relativity theory – the Lorentz Theory. However, 'relativity of uniform motion' is not a logical necessity, and the proposition may well not enjoy unrestricted universal validity. Equally, it is not a logical impossibility. Therefore, it is an admissible proposition for the Natural Philosophy as a contingent precarious proposition – true if the necessary conditions are satisfied, and otherwise false.

In the author's science-play *The Catherine Conspiracy*, Newton and his circle deduce from a few simple ballistic experiments the 'velocity-modifications' that all the physical systems must suffer in their shapes and the rates of physical processes if a Gulliveresque relativity were to obtain on the flying island Laputa.

5. A Retrospect of Ballistic Explanations

The ballistic experiments used by Newton and his circle, and set forth in detail in the author's paper, 'Ballistic Explorations For Relativity' (Journal of New Energy', 2008), involved only the measurements by an observer of the 'transit-durations' of the standard projectiles fired by calibrated guns – meaning the time interval, measured by a standard clock held by the observer, between the transits of the front and the rear ends of the projectile at his own location. No distance measurements or time measurements of distant events are necessary.

From the measurements of 'transit-durations' alone, Newton and his circle deduce the following necessary requirements for Gulliveresque relativity.

1. There exists a critical velocity ' c ', be it a hundred times the velocity of light, or a million times the orbital velocity of the earth, or a trillion times the velocity of sound, or whatever. *What is necessary is that there exists a unique velocity that is critically necessary for the validity of Gulliveresque relativity.*

2. If the standards of length and time are suitably chosen, as we shall do in all of the following work, so that the 'critical' velocity is unity, then if a gun fires a projectile with velocity v* when the gun is at rest, the velocity v of the projectile when the gun is moving in the same direction with velocity u will be given by, $v = \dfrac{u + v^*}{1 + u.v^*}$.

The existence of such a critical velocity is neither a logical necessity nor a logical impossibility. But it is an obligatory requirement for the relativity of inertial motion.

In particular, if v* equals unity, the critical velocity, then v also equals unity. This is, in fact, the second postulate of Einstein in his 1905 paper - with the critical velocity being identified with the velocity of light -, which paper gave an alternative construction of the Lorentz Theory. *This additional postulate is thus not strictly necessary, and is redundant, as the existence of a critical velocity follows necessarily from the postulate of relativity itself.* The magnitude of the critical velocity is a matter of empirical experience.

Some further necessary requirements of the Gulliveresque relativity that follow deductively from the ballistic experiments involving only the measurements of 'transit-durations' and 'transit-rotations' by an observer at his own location are:

3. A body moving with velocity v is contracted by a factor $\beta(v)$ in the direction of its motion, where $\beta(v) = \sqrt{1 - v^2}$. This is the well-known 'Lorentz contraction'.
4. The dimensions of a moving body normal to the direction of motion are not velocity-modified.
5. A clock with velocity v is retarded by the same factor $\beta(v)$, which is the well-known 'Lorentz clock-retardation'.
6. A body moving with velocity v and rotating with angular velocity Ω about the line of the motion suffers a velocity-twist $\chi(v)$ per unit rest-length of the body, about the line of rotation, where $\chi(v) = \dfrac{\Omega.v}{\sqrt{1 - v^2}}$, with the rear end being relatively twisted in the same sense as the rotation of the body. What this implies is that the stress-free stable configuration of a rotating body in motion involves a uniform twist. *This is designated as the 'Catherine Twist' in the author's science play, The Catherine Conspiracy. This most significant 'velocity-modification' finds no mention in the relativity literature, and is scarcely known.*
7. A longitudinally and transversely graduated rotating tube constitutes - like the 'Tacheometry Theodolite', used for topographical land surveys - a self-synchronising 'physics-theodolite', that can be used to determine the locations and times of distant events, without the use of any signals or transports of clocks. The correlations of the measurements obtained by means of a 'velocity-distorted' moving 'physics-theodolite' – a frame of reference - are given by the well-known Lorentz Transformations. *This demonstration falsifies the dogma in the relativity literature that distant clocks cannot possibly be synchronized without either transport of clocks or the transmission of some signals.*

6. Velocity Modifications and Physics

The velocity-modifications required by 'relativity' are real physical effects – as real as those produced by temperature or pressure, and not merely perspectival illusions.

The velocity-modifications encountered thus far are not, however, all that is required for 'relativity'. They are but the tip of a countless horde. Each new refinement of the experimental situation would bring out the necessity of a new velocity-modification. The necessary velocity-modifications would cover the whole field of physical properties – dynamical, elastic, thermal, electric, magnetic, etc. Each one of them is necessary for 'relativity', but no finite set of them would be sufficient.

If even any single one of these necessary velocity-modifications does not occur in the nature then full and exact 'relativity' cannot be possible and 'relativity' has to be abandoned as an absolute principle.

As Newton remarks, physical effects are not brought about by principles and philosophies but by physical forces and actions. Therefore, 'relativity' requires that the forces and actions are compatible with the demands of relativity. Lorentz gave a plausible argument for the 'length-contraction' on the basis of his theory of electrons, which argument was certainly not compelling or conclusive. And physics has not been able to provide any better justification in the next hundred years. For the other necessary velocity-modifications no plausible arguments have even been advanced. It was believed for a time that if all physics were of electro-magnetic origin then the necessary velocity-modifications must follow, since Maxwell-Lorentz electrodynamics can be construed with some reinterpretations to be consistent with the requirements of 'relativity'. But the limitations of Maxwell-Lorentz theory are now well demonstrated, and this argument no longer has a conclusive force.

It could also happen that some two requirements of 'relativity' are mutually incompatible, or some requirement is in conflict with the experience. Any such a conflict would make 'relativity' untenable, and refute it as an absolute principle.

The author has shown such a conflict to occur in the case of the motion of the radiating accelerated electric charges in his papers, "Radiation Reaction Refutes Relativity", (NPA 2006), and, "Radiation Reaction Refutes Relativity", (Indian Science Congress, 2007)

7. Relativistic Mechanics

In his papers, "Ballistic Path to Relativistic Mechanics", (NPA 2009), and "Planck's Theorem Mechanics and Ballistics", (NPA 2009), the author has shown, by analysis of some simple experiments with a spring-gun, that the relativistic particle mechanics, consistent with the dimensional and kinetic modifications obtained earlier, follows from a single modification of the Newtonian mechanics.

The single necessary modification is the change in the definition of 'momentum' through Planck's Theorem (1908), which defines momentum to be 'proportional to the flux of energy'.

Momentum $\mathbf{p}$ is given by $\mathbf{p} = \dfrac{E}{c^2}\mathbf{v}$, where c is some 'critical velocity', and $\mathbf{v}$ is the velocity of the body. Gulliveresque relativity requires that the mass of the loaded gun, involving compression of the spring, differs from the sum of the individual masses of the gun and the projectile separately. Gulliveresque relativity requires that the motion 'velocity-modifies' mass, and that, with the critical velocity being unity, the 'velocity-modification' of the mass is determined uniquely by the factor $\mu(v)$, where

$$\mu(v) = [\beta(v)]^{-1} = \frac{1}{\sqrt{1-v^2}}$$

It can also be concluded from the analysis that Work – the added elastic energy – manifests as a 'latent mass' – a 'non-material mass'. The 'latent non-material' mass also gets velocity-modified in exactly the same manner as the normal material mass, and that dynamically both must be equivalent.

In his paper, "Work And Making Relativity Work" (NPA 2007), the author has shown by the analysis of the rotational stability of a rod pulled on Laputa in opposite directions along the length of the rod by identical horses when Laputa is in a uniform translatory motion, that a stationary current of energy, *called the 'Halley-power-flow'*, possessing physicality and momentum, is necessary for relativity. *It follows that internal energy currents must circulate perpetually in a stressed body even while persisting in an inertial motion.*

These are the currents that occasioned Halley's perplexity – power of thousands of horses coursing through his body without his being aware of it, and initiated the construction of the Gulliveresque relativity on Laputa by Newton and his circle.

Now here we explore by means of similar simple experiments the necessary modifications in respect of the strengths of horses and the elastic properties of solid bodies required for 'Gulliveresque relativity'.

8. Velocity Modifications of Forces

Suppose Laputa is at rest on Balinbari – i.e. at absolute rest. Let a smooth pulley be mounted on a pedestal with a rope around it, with the two sections of the rope being at right angles to one another. Let two identical horses Able and Baker be pulling at the two ends of the rope. Evidently the two horses being identical exert equal forces, say F*, and the rope is at rest.

Now let Laputa be set into a uniform motion with velocity u – in 'critical velocity' units' – in the direction from the pulley to the horse Able. The other horse Baker would then be pulling in a direction normal to the line of motion of Laputa. As a result of the motion of Laputa the strengths of the two horses, could be 'velocity-modified', and these velocity-modifications could be different in the two directions. Suppose the strengths of the two horses Able and Baker are velocity-modified by factors ρ_1 and ρ_2 respectively.Now, if the rope is imparted an infinitesimal 'virtual displacement' towards Able, say δ according to the length markings on the rope, we can determine the velocity-modified horse-strengths on Laputa by using the 'principle of virtual work', or D'Alembert's principle.

While the horse Baker would suffer a displacement δ, the 'true' displacement suffered by Able would be $\beta(u)\delta$, because of the Lorentz- contraction . Therefore by the principle of virtual work we have $\delta\beta(u)\rho_1 F = \delta\rho_2 F$. That is

$$\rho_2 = \beta(u)\rho_1 \tag{1}$$

Now, as for dimensions of bodies or clock-rates, 'universality' is a cardinal requirement of relativity for all velocity-modifications. Force must get velocity-modified in the same way irrespective of the nature or agency of the force.

Consider a ball having mass m, attached by a rod, having length a, to a steel tube which can be imparted any desired angular velocity about a smooth axle mounted horizontally on Laputa. Let the tube and the ball be imparted an angular velocity ω^* as measured by the clock on Laputa when it is at rest. Let K* be the tensile force in the rod, maintaining the ball in its circular motion. Since the ball has a velocity $a\omega^*$, its mass increases by a factor $1/\beta(a\omega^*)$. Therefore, the force in the rod is given by

$$K^* = ma\omega^{*2}/\beta(a\omega^*) \tag{2}$$

Now let the same procedure be followed when Laputa is moving uniformly with velocity u along the length of the axle. Here, because of clock retardations the true angular velocity of the ball will be $\beta(u)\omega^*$. Thus, because of its rotation the ball has a velocity $a\beta(u)\omega^*$ normal to the motion of Laputa. Therefore, the resultant velocity of the ball, say v, is given by $v = \sqrt{u^2 + a^2\beta^2(u)\omega^{*2}}$. The mass of the ball will, therefore, get velocity–modified by a factor $1/\beta(v)$. Here, and hereafter, for simplicity we shall represent $[\beta(u)]^k$ by $\beta^k(u)$

Since the centripetal acceleration of the ball is now given by $a\beta^2(u)\omega^{*2}$, the force K in the rod would be given by

$$K = \frac{m}{\beta(v)} a\beta^2(u)\omega^{*2} \tag{3}$$

$$\beta(v) = \sqrt{1-u^2-a^2(1-u^2)\omega^{*2}} = \sqrt{1-u^2}\sqrt{1-a^2\omega^{*2}} = \beta(u)\beta(a\omega^*)$$

Substituting this in (3), $K = ma\beta(u)\omega^{*2}/\beta(a\omega^*)$, and, then from (2) we have

$$K = \beta(u)K^* \tag{4}$$

Thus we find that for relativity the tensile force in the rod, which is normal to the line of motion of Laputa, must get modified by a factor $\beta(u)$. Therefore, by the requirement of universality, every force normal to the motion of Laputa must get velocity-modified similarly.

Therefore the strength of the horse Baker must get modified by the factor $\beta(u)$. That is, in Eq. (1) above $\rho_2 = \beta(u)$. Therefore, we have $\rho_1 = 1$.

Therefore the strength of the horse Able, pulling along the line of motion of Laputa, will not suffer any velocity-modification. And, by the requirement of universality this should be so for every force acting along the line of motion of Laputa.

Now, because of the Lorentz-contraction suffered by it, the horse Baker would be slimmer or thinner by the factor $\beta(u)$, and it is understandable that its strength reduces by that factor. But, because of the Lorentz-contraction suffered by it, the horse Able is shortened, or stunted by the factor $\beta(u)$, and yet its strength remains unimpaired. This is somewhat odd; but this is what must happen if relativity were to prevail on Laputa. How this could come about as a result of the physiological and cellular velocity-modification of the horse is a matter for the relativity theorists to elucidate.

It may be seen from any treatise on the Lorentz theory – i.e. the special relativity theory –, using tensor analysis and field transformations, that the forces between two electric charges in

Maxwell-Lorentz electrodynamics do satisfy these requirements for the velocity-modifications of the forces. They have been obtained here by some pedestrian considerations of the draught-horses harnessed to a simple Archimedean machine and the dynamic equilibrium of a ball attached to the end of a rotating rod.

Relativity would, of course, also require that an observer traveling on Laputa does not notice any of these velocity-modifications, as a result of the physiological, neurological, and psychical velocity-modifications suffered by him – just as Halley is not conscious of the power of thousands of horses coursing through him. How this could come about is again a matter for the relativity theorists to elucidate.

9. Velocity Modifications of Elastic Properties

Now let the two horses, Able and Baker, instead of pulling at a rope passing around a pulley, be pulling at two identical rectangular horizontal shafts, with isotropic elastic properties, fixed firmly in a massive pedestal on Laputa when Laputa is at rest.

Let the dimensions of the shafts parallel to the plane of Laputa be d* and those normal to Laputa be b*. Let graduated scales be fixed adjacent to the two shafts. Let the natural unstressed lengths of the shafts be L*. Let the Young's Modulus of the shafts be E*. Let the lengths of the elastic shafts increase by e^* as a result of the pulls of the two horses. We have

$$\frac{e^*}{L^*} = \frac{F^*}{b^* d^* E^*} \tag{5}$$

Now let the same exercise be conducted on Laputa when it is in motion with velocity u, in the direction in which the horse Able is pulling. It is not inconceivable that the velocity-modification of the elastic constant could depend upon the direction in relation to the direction of motion – that is to say, motion may modify the shafts into elastically anisotropic bodies.

Let the velocity-modified Young's Modulus for the direction of motion along which Able is exerting his force be $\sigma_1(u)E^*$, and let the true (or absolute) extension of the shaft be $e_1(u)$. Now, since both the sides of the cross-section of the shaft are normal to the line of motion they will remain unaffected by motion, while the length of the shaft will get modified to $\beta(u)L^*$ as a result of Lorentz-contraction. Also, it has been seen above that the motion of Laputa does not affect the strength of the horse Able.

Thus we have $$\frac{e_1(u)}{\beta(u)L^*} = \frac{F^*}{b^* d^* \sigma_1(u)E^*}$$

That is $$\sigma_1(u) = \frac{\beta(u)e^*}{e_1(u)}$$

Now, on moving Laputa, for the relativity to prevail, the extension $e_1(u)$ measured directly on the adjacent graduated scale must be e^*. But this scale would have suffered velocity-modification by a factor $\beta(u)$. Therefore, we have, $e_1(u) = \beta(u)e^*$. Therefore $\sigma_1(u) = 1$; which implies no velocity-modification.

Now consider the case of the horse Baker. His strength is reduced by a factor $\beta(u)$. The side of the cross-section parallel to Laputa suffers Lorentz-contraction, while the other side remains unaffected. The length of the shaft remains unaltered. Suppose the elastic constant is modified by a factor $\sigma_2(u)$, and the true extension is $e_2(u)$.

Thus, we have $$\frac{e_2(u)}{L^*} = \frac{\beta(u)F^*}{b^* \beta(u) d^* \sigma_2(u)E^*}$$

That is $$\sigma_2(u) = \frac{e^*}{e_2(u)}$$

The extension $e_2(u)$ measured directly on the adjacent scale must be e^* for relativity to prevail. Now this scale, being normal to the direction of motion, is not velocity modified. Therefore, we have, $e_2(u) = e^*$. Therefore, $\sigma_2(u) = 1$; which again implies no velocity-modification.

Thus relativity demands that Young's Modulus of an isotropic body is not modified by motion, either in the direction of motion, or in a direction normal to it. It is rather surprising that while motion must modify dimensions and inertia of the solid bodies it should leave the elastic constant unaltered, which requires justification from the physics of the solid state.

10. Maxwell-Flexures Jeopardize Relativity

We may now contemplate some exercises on Laputa in which the two horses Able and Baker endeavour to flex, or bend the shafts, instead of trying to extend them. The theory of the flexure of elastic beams was worked out by Maxwell, and may be seen in any treatise on 'strength of materials', or 'structural mechanics', and underlies all structural design.

The basic equation of Maxwell's theory of flexure of beams, based on the classical theory of elasticity, reads, $\frac{M}{I} = \frac{E}{R}$, where M is the bending moment, I is the moment of inertia of the cross-section, E is the Young's Modulus, and R is the radius of curvature of the bean, at any cross-section of the beam along its length. From this basic equation we can determine by integration the slope, the deflection, the stresses, etc. at any point by taking account of the forces acting upon it, the boundary conditions at the supports, the variations of the elastic and geometric properties of the beam along its length.

Now suppose that the two horses Able and Baker pull at the ends of their shafts in a direction normal to the length of their respective shafts, which are firmly anchored in the pedestal. The shafts will bend, and the ends will deflect. Let adjacent graduated scales be provided upon which the deflections can be read directly.

When Laputa is at rest the two deflections are obviously equal, say δ^*. In technical parlance this is a standard problem of the deflection of a uniform cantilever beam under a load acting at the free end, and the deflection is given by, $\delta^* = \frac{F^* L^{*3}}{3E^* I^*}$ where I* is the moment of inertia, and this standard result can be found in any book on structural analysis. For the rectangular section with breadth b* and depth d*, $I^* = (1/12)b^* d^{*3}$.

Therefore, we have $$\delta^* = \frac{4F^* L^{*3}}{E^* b^* d^{*3}} \tag{6}$$

Now suppose the same exercise is conducted when Laputa is moving with a velocity u in the direction of the shaft at which

Able is pulling. Taking into account the velocity-modifications suffered by the horse and the shaft, as determined above, the true deflection $\delta_1(u)$ effected by Able will be as

$$\delta_1(u) = \frac{4\beta(u)F^*\beta^3(u)L^{*3}}{E^*b^*d^{*3}} = \beta^4(u)\delta^*$$

For the deflection $\delta_2(u)$ effected by Baker

$$\delta_2(u) = \frac{4F^*L^{*3}}{E^*b^*\beta^3(u)d^3} = \frac{\delta^*}{\beta^3(u)}$$

Now the two deflections are not equal, as they were with Laputa at rest, and neither of them equals δ^* as required for relativity. The difference between the two is perhaps understandable because $\delta_1(u)$ is effected by a weakened horse pulling at a stiffer beam with a shortened lever-arm, whereas $\delta_2(u)$ is effected by a horse with unimpaired strength pulling at a beam with reduced stiffness and original length. The difference will be still further accentuated in the deflections directly read on the adjacent scales, because the scale on which $\delta_2(u)$ is read is Lorentz-contracted. If we denote by asterisks the actual readings on the scales, we have,

$$[\delta_1^*(u) / \delta_2^*(u)] = \beta^8(u)$$

This is quite embarrassing, and can be fatal for relativity. The deflection of a cantilever, or indeed of any beam, can then be used to detect and determine the motion of Laputa by means of purely internal experiment conducted on Laputa.

If a horizontal beam fixed on a rotatable platform on Laputa were loaded in the plane parallel to the floor by means of a stretched spring the deflection of the beam will depend upon the orientation of the beam with respect to the direction of motion of Laputa as well as the magnitude of the motion of Laputa. By noting the deflections recorded on the attached scales for different orientations of the beam and different spring loads it could be possible to determine the direction and the magnitude of the motion of Laputa.

11. Conclusion: Ghostly Rescues

In the case of the 'Lewis and Tolman Lever' the rotational stability is secured by the ghostly action of the 'Halley power flows' – or 'momentum densities', as they are called. There is no experimental corroboration of the required rotative effect of the ghostly energy flows in any mechanical system, but the concept is not logically impossible, and could be provisionally adopted. Could similar ghostly actions come to the rescue here?

In the case of the shaft being pulled by the horse Able, no external work is being done as the force is normal to the line of motion, and no momentum densities occur because of the external force. The momentum densities generated by the bending stresses would be equal and opposite, constant in time, and would be parallel to the direction of motion, and would not give rise to any torque acting on the shaft. Therefore, $\delta_1^*(u)$ would not be modified by the action of the internal circulating 'Halley power flows'. Since $\delta_1^*(u)$ differs from δ^* the possible rotational action of 'Halley power flows' fails to rescue relativity.

Although this is sufficient to jeopardize relativity, we may also consider the deflection of the other shaft being pulled at by the horse Baker. Although the equal and opposite power flows due to the bending stresses are normal to the line of motion, they would not result in any rotative action on the shaft because they are equal, opposite, and constant in time. The horse Baker will be doing work, and imparting energy continuously to the shaft, which energy will flow out into the pedestal in which the shaft is fixed. This will engender a 'momentum density' F^*L^*u in the shaft. Since the shaft is normal to the line of motion of Laputa, there could possibly be a rotative action $F^*L^*u^2$ engendered as a result of the motion of Laputa. This 'couple' would be acting to oppose the bending caused by the pull of the horse Baker. The actual deflection, say $\delta_2^{\otimes}(u)$ would be the resultant of the two actions.

The deflection due to the latter action can be taken to be the central deflection of a beam of length $2L^*$ under the action of equal and opposite couples acting at the two ends, with the bending moment being constant along the length of the beam, and is given by

$$\delta = \frac{L^*M}{2R} = \frac{L^*M}{2.E^*I} = \frac{6L^*F^*L^{*3}u^2}{E^*b^*\beta^3(u)d^{*3}} = \frac{3u^2}{2\beta^3(u)}\delta^*$$

Correcting for this ghostly effect the resultant deflection is given by

$$\delta_2^{\otimes}(u) = (1 - \frac{3}{2}u^2)\frac{\delta^*}{\beta^3(u)}$$

But the actual deflection read on the adjacent graduated scale would be modified by the Lorentz-contraction of the scale. Thus the possible restorative effect of the ghostly 'momentum density' fails to rescue relativity, and the relativity is in jeopardy.

It is, of course, conceivable, and not impossible, that there could be other ghostly entities besides the 'Halley power flows' that may yet rescue relativity.

Relativistic mechanics of continuous media, based on 2-index stress-complex has been widely studied. But all those studies fail to do justice to the known elastic properties of solid bodies, and are possibly suitable only for mechanics of ideal perfect fluids.

It is not absolutely impossible that with sufficient and suitable further ghostly actions a fully relativistic formulation for the theory of the flexure of beams, providing the stresses, the deformations, and the deflections, could be possible. That could require a fuller theory based not merely on the Young's Modulus but on the generalization of Hooke's Law, involving 4-index 256-component elastic complex. But no such theory is yet available.

Such a theory would be required to be compatible with 4-index elastic-properties of solids, for which there are no counterparts in electromagnetism or fluid mechanics for guidance. There would also be a vast number of physical compatibility conditions that may possibly be found to be algebraically incompatible.

Elastic deformations of moving solid bodies under external actions provide for the relativity theorists a luxuriant field for exploration that is still almost virgin and has scarcely been scratched.