

Einstein not yet displaced

Controversial theory of varying speed of light still lacks a solid foundation.

Faster Than the Speed of Light: The Story of a Scientific Speculation

by João Magueijo

William Heinemann/Perseus: 2003. 320 pp.

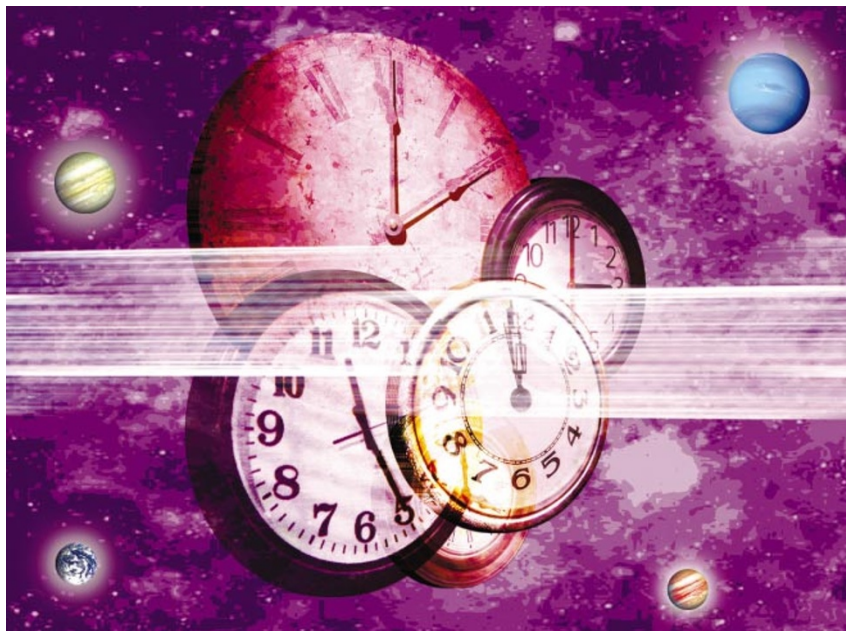
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George Ellis

João Magueijo is one of many who hope to see the epitaph 'Einstein was wrong, I was right' on their gravestone. He is a cosmologist who, one rainy morning in Cambridge, suddenly saw the possibility of a varying speed of light (VSL) as an alternative to the inflationary-theory paradigm that dominates present-day theoretical cosmology. He knew from the start that it represented a fundamental challenge to physics orthodoxy (it violates the foundations of Einstein's special theory of relativity) and would not easily be accepted, but he worked enthusiastically to develop the idea. He found a collaborator who wavered but eventually completed a joint paper with him on the topic. This was rejected by major journals but was eventually accepted for publication after a long battle. He then discovered that the idea had already been proposed, in a slightly different form, by John Moffat. He found new collaborators and with them developed variants of his theory.

Faster Than the Speed of Light is a lively book that captures the excitement and frustrations of doing real-world science. Magueijo relates interestingly how his VSL proposal might possibly be a way out of some major puzzles facing cosmology, which he explains well. There are irritating passages, however, where he makes extended use of a metaphor involving farmers and cows in explaining relativity theory. Magueijo states that this is based on a dream that Einstein had as a boy — a fictional invention that displays such a cavalier attitude to historical truth as to call into question his other historical claims (and for the record, it was Richard Tolman, not Yakov Zeldovich, who first investigated the thermodynamics of bouncing universes). And at times Magueijo descends to an altogether different space characterized by hostile ranting ("seem to fancy themselves as scientific pimps") and crude language. In these passages he expresses his profound dissatisfaction with how he has been treated by the scientific world despite the recognition and generous support he has received (he was awarded a Cambridge fellowship and a Royal Society research fellowship, and is a reader at Imperial College, London).

His papers on VSL have now been widely



read and referred to. Why, then, his major discontent? He has had no more difficulty than many others who have presented challenges to orthodoxy. All major new ideas have been resisted in their time: the expanding Universe, continental drift, special relativity and quantum theory, for example. Science is inherently conservative — it has to be so, given the flood of speculative writing. It also has to be open, allowing dissemination of unorthodox views, which does occur. It is resistive but not impermeable, as is shown in his own case. There is a valid complaint, nevertheless: the current use of refereeing as a defence of the inflationary-theory orthodoxy in cosmology is indeed regrettable.

Magueijo's dissatisfaction is wider than that, however. He criticizes all university administration as parasitic and unnecessary, throwing in gratuitous insults as he does so. He is breathtakingly arrogant as regards funding — he seems to assume it is his right to be funded for the work he is doing with no questions asked. He gives no attention to the methods by which one can decide how public funding should be dispensed in science, nor to why the public should pay any money at all to people like him. Yes, there are problems in university organization and the funding system; constructive criticism is justifiable and indeed needed. But his remarks are purely destructive.

What of the VSL theory itself? Is it the panacea he hopes for? No, it is not. Einstein reflected deeply on the foundations of physics, and that was the basis of his success.

Magueijo has not gone back to the foundations and sorted them out. Any theory of this kind needs, first, a viable proposal for measuring both time and distance, as velocity is based on this; second, a physical model that embodies the results of these measurements in some well-defined mathematical structure; and third, a theory of electromagnetism that predicts the speed of light in relation to these measurement processes. He has none of these, and without them he does not have the basis to put his theory on a solid foundation.

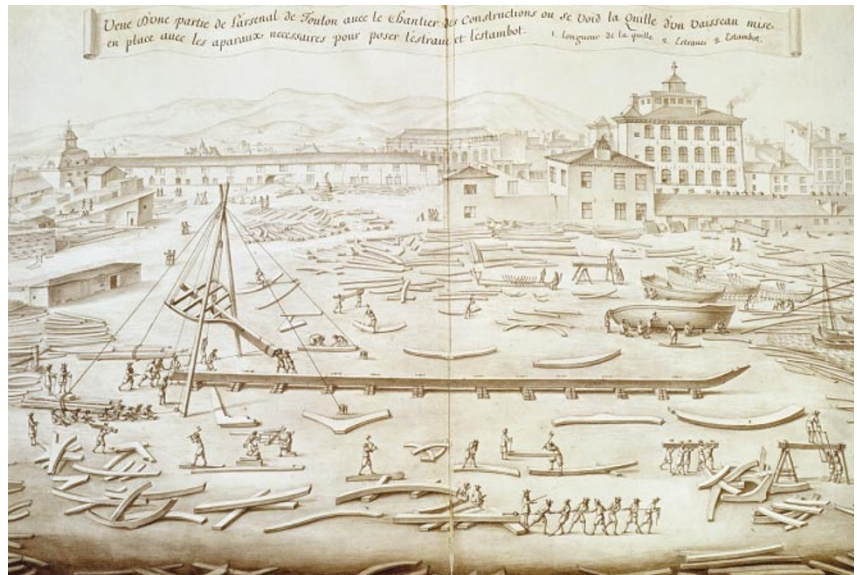
Standard relativity theory deals with all these issues in depth. The key point is that current ways of measuring distance precisely incorporate the speed of light in their foundations. On large scales, radar (with its variants such as the Global Positioning System) is the only viable method. It is then not possible for the speed of light to vary, because it is the very basis of measuring distance; as emphasized by J. L. Synge, the natural units for distance are light seconds or light years, rather than metres or miles. Furthermore, this is then built into the foundations of the theory through the space-time metric tensor and its interpretation as determining proper time (time measured by an ideal clock along its worldline), proper distance (measured by radar), and the null cone (characterizing the path of light through space-time). Because Magueijo and Moffat ignore this physical interpretation of the metric, their so-called 'phase transition in the speed of light' is just a jump in arbitrary

units for time, unrelated to measurement procedures. It is not a physical prediction.

Furthermore, the variation principles proposed as underlying the physics involve the metric tensor in raising and lowering indices to create scalars — and hence build into the foundations of the theory the invariance of the speed of light (the metric determines the speed of wave propagation). We are given no reason why any broken symmetries associated with special solutions of the resulting equations will give a causal explanation for a varying speed of light — but this variation is the arbitrary postulate of VSL theory. And apart from the part of the action determining variation of the speed of light (independently of Maxwell's equations), the explicit occurrence of the speed of light in the VSL variational principle proposed is only in a ratio with the gravitational constant G — so this is just a varying- G theory in disguise.

Developments that could make VSL viable, such as further investigation of the time variation of the fine-structure constant, of two-metric theories, of an altered version of the symmetry group underlying relativity theory, or through a string-theory motivation for varying 'constants', need to provide a clear relation to space and time measurement, as well as a physical reason (based in some version of Maxwell's equations) for the speed of light to vary. It is a pity that Magueijo does not mention progress made in these directions by workers other than himself and his own collaborators. ■

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More than the sum of its parts: the relationship between the planks determines what kind of boat it is.

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C'est la vie?

The Delphic Boat: What Genomes Tell Us

by Antoine Danchin, transl. Alison Quayle
 Harvard University Press: 2003. 368 pp. \$35, £23.50, €35

Axel Meyer

This contribution from old Europe's *grande nation* discusses genomics, the politics of genome research, the philosophy of science, and the not-so-small question of the nature

of life. The first problem faced by the author, Antoine Danchin of the Pasteur Institute in Paris, France, is how best to describe a genome. He borrows from Greek mythology the tale of the oracle of Delphi, which asked whether a boat that has had all of its planks replaced over time is still the original boat or not (to its owner, who watched its evolution, it would be). Danchin makes the point that it is the relationship of the planks (or in the case of the genome, the genes) to each other that determines what kind of boat (genome) it is; individual planks are less important in determining the essence of a boat.

It has been known for some time that a genome is not merely a set of independent genes arranged like pearls on a string. The essence of a genome has been described as a code, a blueprint, a musical score and a set of instructions. All of these metaphors are used in an attempt to convey the notion that a genome is more than the sum of its parts.

From an evolutionary biologist's point of view, each organism's genome (including our own) is a record of its evolutionary history: genomes are shaped by symbioses and hybridizations, as well as by natural selection. In attempting to understand the origin and diversification of life, the increase in complexity during ontogenetic development, and even more straightforward questions such as the genetic bases of diseases, the study of individual genes will reach its limits and fall short of a more holistic appreciation that considers the entire genome (and the entire phenotype). Genes 'talk' to one another, regulating each other's expression in response to environmental conditions and the prevailing ontogenetic or metabolic state of the cell or organism. Genes are also affected by their position in the chromosome, by the base composition

Preying for dinner-time

Mantids are ambush predators that keep still and wait for other insects to approach before striking and feeding on them. Like other mantids, the female mantis *Harpagomantis discolor* shown here is camouflaged and remains motionless, or rocks slightly from side to side as if swaying in the breeze, all the while keeping its forelegs folded in a manner reminiscent of prayer. When another insect comes close, the mantis snatches it and holds it in a pincer-like grip while devouring it alive. Mantids are just one of the arthropod orders included in *The New Encyclopedia of Insects and their Allies* (Oxford University Press, £25), edited by Christopher O'Toole.

