Einstein Plus Two

By
Petr Beckmann

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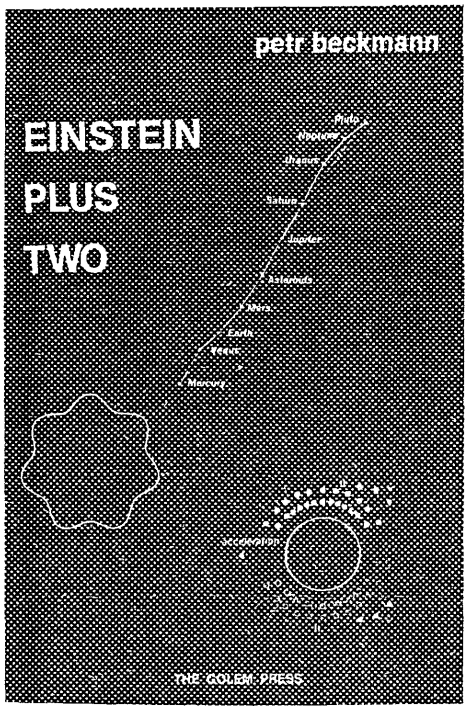

Preface

When I run, I feel a wind; but not one that will make a windmill turn.

As long as an observer is at rest on the ground, it does not matter whether the velocity of the wind is referred to the observer or the windmill. A physicist who *falsely* assumes that the effect-producing velocity (that makes the windmill turn) is that with respect to the observer, but *correctly* applies the relativity principle, will expect the windmill to turn when he is running. The experimental evidence will contradict his expectation, and he can then either abandon his false premise, or he can so distort space and time that the observer's motion produces two exactly equal and opposite forces on the windmill, keeping the mill motionless as observed. The Einstein theory, in effect, takes the latter road; but I believe the laws of physics, including the relativity principle, must hold regardless of any observer, who should do nothing but observe.

An electric or magnetic field will accelerate an electron. Its magnetic field will therefore increase, which causes the induced electric field to decelerate it. That will decrease the magnetic field and the induced electric field will accelerate the electron again. The resulting oscillations are derived from the Maxwell equations in Part Two of this book. They explain the quantization of electron orbits, the de Broglie relation and the Schrödinger equation simply and without further assumptions.

The natural frequency of these oscillations depends on the velocity of the electron; but the velocity with respect to what? The velocity that will make the Lorentz force and the Maxwell equations valid, claims the Einstein theory, is the velocity with respect to the observer. But if so, does the electron oscillate for me because I am moving past it, but not for you because it lies still in your rest frame? To answer yes is to kill the relativity principle.

As I will attempt to show, the velocity that makes the Maxwell-Lorentz electrodynamics valid is that of charges with respect to the local fields they traverse. That squares with the experimental evidence in electromagnetics and optics, and it leads to the derivation of two phenomena for which no explanation other than *ad hoc* postulates has hitherto been available: the quantization of electron orbits and in the realm of gravity, the Titius series.

Why, then, has the Einstein theory celebrated an uninterrupted series of brilliant successes for more than 80 years?

Because in all past experiments the observing instruments have always been nailed to the local field, so that they could not reveal whether the observed effect was associated with an observer-referred or a field-referred velocity. The technology for testing that difference may not be available for some time.

But if it is field-referred velocities that are the *effect-producing* ones, then the Maxwell equations automatically become invariant to the Galileian transformation; the undisputed fact that the Lorentz force and the Maxwell equations with *observer*-referred velocities are Lorentz-invariant is one that becomes both trivial and irrelevant.

I am not so naive as to think that the first attempt to move the entire Einstein theory *en bloc* onto classical ground will turn out to be perfectly correct. What I do hope is that the approach will provide a stimulus for the return of physics from description to comprehension. Attempting to redefine the ultimate foundation pillars of physics, space and time, from what they have been understood to mean through the ages is to move the entire building from its well-established and clearly visible foundations into a domain of unreal acrobatics where the observer becomes more important than the nature he is supposed to observe, where space and time become toys in abstract mathematical formalisms, and where, to quote a recent paper on modern approaches to gravitation theory, "the distinctions between future and past become blurred."

This book is for those who do not wish to blur such distinctions ("He will commit posthumous suicide yesterday"?). It is for those who seek to understand rather than merely to describe; for those who will accept the Einstein theory as a brilliant, powerful and productive equivalence, but not as a physical reality.

It is for those who are prepared to sacrifice a lifetime's investment in learning; and perhaps more importantly, for the young students who have not yet made such an investment.

* For more information on the author see *American Men of Science*, *Who's Who in America* or *Who's Who in the World*.

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EINSTEIN PLUS TWO

By PETR BECKMANN, Professor of Electrical Eng., Univ. of Colorado, Fellow of the I.E.E.E.

In 1912, Yale phyics professor Leigh Page proved that the Maxwell equations could be derived by applying the Lorentz transformation to Coulomb's Law. This was regarded as a triumph of the Einstein theory, but it also showed that the successes of the Einstein theory may be due to the Lorentz transformation compensating for an inverse-square law that becomes inaccurate at high velocities.

This book is based on the assumption that the velocity that will make the Lorentz force and the Maxwell equations valid is not that with respect to an observer, but that of charges (and masses) with respect to the traversed dominant field. In particular, the velocity of light is constant with respect to the local gravitational field.

This results in a rational, simple theory that satisfies the relativity principle without having to modify space and time. It derives all experimentally verified phenomena following from the Einstein theory, plus two more: the quantization of electron orbits (plus the Schrödinger equation), and the Titius series of planetary distances.

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Test yourself:

Right or Wrong?

• An accelerated electron must radiate.

Wrong. The electrons oscillating in a microwave transmission line are accelerated millions of times every second, but if the line is terminated by a matched impedance, they do not radiate — as we know from both theoretical derivation and experiment. It is true that all electromagnetic radiation is due to accelerated electrons; but the converse (all accelerated electrons radiate) does not follow.

When an electron undergoes oscillations that accelerate it in free space with respect to its own field (as qualitatively described in the Preface on p.1 of this flyer), it undergoes *natural* oscillations at a *natural* frequency determined by its energy. A detailed calculation of the Poynting vector, performed in the book, shows that energy moves from kinetic energy associated with the electron itself to its electromagnetic field and back again (as one might expect even from that qualitative description): the Poynting vector reverses direction twice per cycle because the electric and magnetic fields are in phase quadrature. This differs markedly from the case of *forced* oscillations of an electron, forced by an external source of energy (as in a radio antenna), when its electric and magnetic fields oscillate in phase, change direction simultaneously, and therefore produce a Poynting vector always in the same direction, namely that of propagation.

• The Einstein formula for the advance of Mercury's perihelion was first derived by Albert Einstein from his General Relativity Theory in 1915.

No. It was derived 17 years earlier by Paul Gerber, by classical physics and under the same assumption as in the present book — that gravity propagates from its source with velocity c. This is easily checked in any college library that has the 1898 volume (vol. 43) of *Zeitsch. f. Mathem u. Physik*; Gerber's paper "Die räumliche und zeitliche Ausbreitung der Gravitation" is on pp.93-104. The "Einstein" formula appears on p. 103.

• Since the velocity of light is a universal constant, light propagates with a constant velocity from west to east (with the rotation of the earth) and east to west (against it).

Right only if one *defines*, as Einstein does, the velocity of light as a universal constant, and then invokes General Relativity (Special Relativity is not enough) to produce the time dilations and space contractions necessary to explain the experimental evidence: the two light beams, if made to interfere, will produce a fringe shift with respect to a control loop in which the velocities cancel. The explanation by Galileian relativity needs only two or three lines of high-school algebra.

The experiment was performed by Michelson and Gale in 1924 in Clearing, Illinois, in evacuated pipes (glass cannot be used as Fresnel drag would compensate for any difference). With an interference loop 6,246 feet or some 10^{14} wavelengths long, it is perhaps the most grandiose interference experiments ever performed; its accuracy still greatly exceeds today's techniques by masers and the Mössbauer effect.

Yet this experiment of fundamental importance, explainable either by the tensors of General Relativity or by the simplicity of the Galileian transformation, rarely makes it into the basic textbooks. Instead, they make the case for the Einstein theory by the the basic textbooks. Instead, they make the case for the Einstein theory by the Michelson-Morley experiment, which is explainable by no less than four different theories (Einstein, entrained-ether, ballistic, and gravitational).

• The experimentally demonstrated velocity dependence of mass and the mass-energy formula cannot be derived without the Lorentz transformation.

They *are* so derived in the book — from no more than the Principle of Relativity and the Maxwell Equations.

• The acute angle made by the paths of elementary particles after collision favors the Einstein theory over classical physics.

Quite the contrary. In view of the preceding item, there should be no difference. But there is one, since the derivation in both cases relies on the conservation of momentum. In classical physics, the latter rests on the equality of action and reaction, but thoughtful Relativists always introduce conservation of momentum without referring to this fundamental principle, which is contradicted by the Einstein theory. For example, the force by a stationary charge on an equal charge moving at right angles to the line joining them differs from the force by the latter on the former: the two forces are $\mathbf{F}_{12}=q\mathbf{E}_1$ and $\mathbf{F}_{21}=q\mathbf{E}_2$, but though the charges are equal, the fields are not — the moving charge has its lines of force bunched by space contraction, and the magnetic force cannot compensate (there is none).

• The Maxwell Equations and the Galileian transformation cannot be simultaneously valid if the Relativity Principle is to hold.

The Maxwell equations proper do not contain an explicit velocity; they contain it implicitly only in the current density ($\mathbf{J}=\rho\mathbf{v}$). Velocity is contained explicitly in the Lorentz force, which is ultimately our only way of measuring electromagnetic fields. If the velocity that makes the Maxwell equations and the Lorentz force valid is the relative velocity of charge with respect to traversed field (not the observer), then the Maxwell-Lorentz equations satisfy the Relativity Principle automatically. The undisputed fact that the Maxwell equations are invariant to the Lorentz transformation is a very different statement from the one above.

• The successes of the Lorentz transformation, the results of the Michelson-Morley and Ives-Stilwell experiments, and the numerous correct predictions guarantee the validity of the Einstein theory.

A thousand confirmations of a theory do not prove it, for a single discrepancy can destroy it — as shown by the ether theory, which also boasted an uncommon number of correct predictions in its day. Moreover, certain aspects of a theory do not get verified until challenged by a rival theory. (As an historical curiosity, one might add that the three authors above, Hendrik Lorentz, Albert Michelson and Herbert Ives did not accept the Einstein theory, and remained resolutely opposed to it to their deaths in 1927, 1931 and 1953, respectively.)

Some early comment:

This book is a major contribution to the very foundations of physics and electrical engineering. Although it is really a revolutionary book, devastating to Einstein's relativity, it is written without bias and with consideration and credit where credit is due.

Dr. Beckmann has talent for providing simple analogies that make subtle physical phenomena easily understood. So the book is very readable. Nevertheless he does not hesitate to go into whatever level of mathematical or physical analysis that is required for scientific credibility.

In addition to the original contributions, and they are numerous, the book provides a valuable historical background...

Thomas G. Barnes
Professor Emeritus of Physics
University of Texas at El Paso

The greatest crime scientists can commit is to distort the results of experiment to support their theories. I can understand your admiration of Michelson and his anger with Einstein...

Every success to your book.

Dr Louis Essen
Former Director
Time and Frequency Division
National Physical Laboratory
Teddington, England

It was with some trepidation that I agreed to review a book which offered to challenge Einsteinian relativity. Were it not for Prof. Beckmann's excellent publication record and credentials... I would not have agreed to the task...

Frankly, I expected an easy go of it; what I discovered is worthy of a wide audience... Regardless of whether Beckmann's hypothesis is finally discovered to be correct or not, one cannot ignore some very cogent arguments which he presents.

Howard C. Hayden
Professor of Physics
University of Connecticut
Storrs, Conn.

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Recommended by: *Date:*

Doubting Dada Physics

by Tom Bethell

I reached Petr Beckmann by phone at the Community Hospital in Boulder, Colorado. He sounded very weak. He had an infected kidney, a complication of prostate cancer. He was eager to get back home so he could finish the July issue of his newsletter, *Access to Energy*. He would be telling his readers that he couldn't go on publishing it and that his good friend Art Robinson would soon take over. (A biochemist, Robinson was at one point scientific director of the Linus Pauling Institute.)

Beckmann has long been an inspiration to me. His newsletter exposes the political abuse of science, and brilliantly elucidates many scientific issues. In his house in the foothills of the Rockies, he has a printing press, and there he also publishes a journal called *Galilean Electrodynamics*. Over the last twenty years he has published many other pamphlets and books: *The Health Hazards of Not Going Nuclear*, *Musical Musings*, a book about language.

He was born in Prague in 1924. Both his parents were Communists. A refugee in England during World War II, he joined a Czech RAF squadron and repaired radar equipment. After returning to Czechoslovakia, he earned a Ph.D. in electrical engineering, then defected to the U.S. in 1963. He taught at the University of Colorado until he took early retirement in 1981. I have had the privilege of talking to him for many, many hours, and one day I hope to write a memoir of him. At some point in the next century, I believe, people will want to know more about this solitary genius, who found his own audience and published his own ideas and discoveries at a time of growing intellectual corruption in the academy. Above all, he is likely to be remembered for having undermined Einstein's theory of relativity, and for showing how physics could be returned to the classical foundations from which it was dislodged at the beginning of the twentieth century.

Ever since he learned relativity theory, Beckmann felt there must be something wrong with it. When he retired from teaching, he returned to the subject, spending several years on a book called *Einstein Plus Two* (1987).[1] He believes now that relativity theory "has been confirmed only in a narrow sector of physics, leads to logical contradictions, and is unable to derive results that must be postulated, though they are derivable by classical methods." He also believes that the theory is definitely falsified by the aberration of light from binary stars. An article to this effect will be published in the next issue of *Galilean Electrodynamics*.

The problem that Einstein tried to solve, the new problems that arose with his solution, and Beckmann's brilliant resolution of all these difficulties, are not so difficult as they may sound. In fact, mystification has greatly enhanced Einstein's reputation. I hasten to add that Beckmann is a great admirer of Einstein, whose famous equation of energy and mass, $E=MC^2$, is unaffected by all this; in fact, it was derived independently of relativity.

By the mid–nineteenth century, the evidence that light travels in waves had become overwhelming; wave theory accounted for refraction, polarization, and many other phenomena of light. The great puzzle was to understand what medium it travels in. Sound needs air; light needs . . . what? It can travel through a vacuum, through interstellar space. But if it is a wave, there must be an oscillating medium, however rarified. This medium was called the "ether" and the great challenge for nineteenth-century physicists was to detect it.

The most famous experiment was carried out by Michelson and Morley in 1887. Since the Earth must be moving through this ether in its orbit around the sun, it should be possible to detect an "ether wind," just as it is possible to feel the wind by putting your hand out a moving car. Albert Michelson, the first American to win the Nobel Prize in physics, designed the apparatus to measure it. But despite repeated attempts, no ethereal breeze could be detected. (Michelson's "interferometer" had been expected to measure a "fringe shift" where criss-crossing light rays were brought together.) This "null result" threw the world of physics into disarray. A wave without a medium!

Enter Einstein, fresh from the Bern Patent Office. He posited that there was no medium, and that the speed of light is the same in all directions, irrespective of the motion of any apparatus set up to detect it. His famous 1905 paper, setting forth the special theory of relativity, demonstrated that if these odd assumptions are made, everything can be shoe-horned in mathematically. But it *was* odd. If a sound wave moves toward you at 750 miles an hour, and you walk toward it at 5 mph, you will detect the sound approaching at 755 miles an hour. Observation agrees with common sense. The same is true of all other waves one can think of. But not electromagnetic phenomena (including light), said Einstein. The velocity of light was accorded a privileged, "absolute" status. Move toward the light source, and you will detect it approaching you at the same speed as someone who is standing still.

That was where absurdity came in. To preserve the absolute nature of the speed of light, space and time had to be distorted.

Tom Bethell is The American Spectator*'s Washington correspondent.*

[1] Available for $36 from Box 251, Boulder, Colorado 80306. Warning: It's technical.

Two twins are the same size: If A moves, he sees B smaller than himself. But B likewise sees A as smaller than *him*self. Which is absurd. Reality becomes observer-dependent, in opposition to the most basic precepts in science. The alpha and omega of the material world—the irreducible character of time and space—were sacrificed in order to preserve an absolute velocity. But velocity itself is nothing but space (distance) *divided* by time! This was Dada Physics. (It's interesting that the Dada movement, "having as its program the discovery of authentic reality through the abolition of traditional cultural and aesthetic forms," came right after the general relativity theory [1915].)

Beckmann says that most students of physics shrug and accept relativity theory—theirs is not to quarrel with the sainted genius of the twentieth century. Some have private reservations. Among intellectuals in general, the theory has been much admired: so abstruse, so deliciously disrespectful of the eternal verities, so marvelously baffling to the bourgeoisie. It doesn't interfere with the daily routine, makes no practical difference to the Newtonian world. But it does upset its theoretical underpinnings. Wonderful! The Muddled Majority who feel so reassured by their common-sense understanding of the world just don't realize that things aren't what they seem to be at all.

Pondering the theory in the late 1950s at Prague's Institute of Radio Engineering, Beckmann concluded that there had to be a medium for light, and in an offhand comment, a student named Pokorny, a (then) devout Communist, suggested the correct answer, as Beckmann is now convinced: the medium for electromagnetic waves is the local gravitational field—dense near the sun, attenuated in outer space. On Earth, the local field is that of the Earth itself. The point is, the Earth's gravitational field moves along with the earth. So that was why Michelson-Morley could detect no ether wind. It was like sitting in a jet as it goes down the runway, holding a toy propeller in your lap and expecting the wind to turn the blades. Absurd—the air in the cabin is moving forward with the plane.

But wait! The Earth also rotates on its axis, and there is good reason to think that the gravitational field does not go around with the Earth. Imagine this field as a hoop skirt on a woman with a circular waist. As she walks forward the skirt moves with her. But then, as she walks, she pirouettes, and now her body will slip around inside the skirt.

If this analogy is correct, the Michelson-Morley experiment might have been able to detect a fringe-shift after all—but a much smaller one than they had been looking for. In the latitude of New York the rotational velocity of the Earth is just one-hundredth of its forward movement around the sun. The relevant equation requires that this fraction be squared. So the expected fringe-shift would only be one ten-thousandth of what Michelson-Morley looked for. Even with today's equipment, such a shift would be difficult (although possible) to detect. It could easily be detected on the space shuttle, because the shuttle goes through the gravitational field much faster than the Earth.

Here are a few little-known points, casting doubt on Dada Physics. Michelson himself never accepted relativity theory, and toward the end of his life he developed an "entrained ether" theory similar to Beckmann's. In 1925, with a colleague at the University of Chicago, he did a complex experiment with very long light-paths (Michelson-Gale), and it did show a confirming fringe-shift. The experiment is omitted from almost all physics texts today.

Electromagnetic signals travel from Washington to Los Angeles more quickly than they do coming back. The difference is very small—37 nanoseconds—but consistent and repeatable. This is exactly what Beckmann's theory would predict, but it is something of an embarrassment to Einstein (who did not know about it; only recently have clocks been accurate enough).

Howard Hayden, a professor in the Physics Department at the University of Connecticut (Storrs), has taken up the cudgels for Beckmann, and has been giving talks on the subject to physics departments in New England. The response has been respectful: some puzzlement, no contradictions, only one or two indignant folk walking out in a huff. Hayden makes the following amazing claim: the constancy of the speed of light, irrespective of the observer's movement, has not been demonstrated experimentally. Hayden and Beckmann are offering a $2,000 reward (hereby offered to *American Spectator* readers) to anyone who can (pay attention) cite in the literature a valid optical experiment demonstrating that the speed of light east to west on the Earth's surface is the same as it is west to east, to an accuracy of 50 meters per second. Note: the experiment does not have to be done, merely cited. In response to an earlier article I wrote on the subject, this offer was published in *Science* magazine (November 30, 1990), but there were no takers.

Beckmann now says that the aberration of light from binary stars definitely refutes Einstein. "Without any equivocation," Hayden confirmed, "I can say that the stellar-aberration prediction of Einstein is wrong." Hayden's goal is to repeat Michelson-Morley in the space shuttle. He thinks he may have a shot because one of the astronauts is his former student.

Here's another surprise. A heralded confirmation of Einstein was the small discrepancy between the orbit of Mercury and the result predicted by Newton. Einstein's formula explaining Mercury's orbit was published in 1915 and was derived from general relativity, using very complex mathematics. Beckmann then found out that the same formula exactly had been published in 1898 by a man named Paul Gerber, who lived in Stargard, Germany, and was apparently a high school teacher! Gerber had used classical physics, plus the assumption that gravity propagates with the speed of light, not instantaneously, as Newton had assumed.

Beckmann found this information in another self-published book, put out in 1982 by someone in Cornwall, England. When the author heard that Beckmann's Czech/RAF squadron had been stationed in Cornwall, he sent Beckmann a free copy. "The guy's a nut," Beckmann said when he saw it, "like people who say chess is in the Bible." Gerber had beaten Einstein by seventeen years, using classical physics? How come this wasn't in the textbooks? Beckmann immediately bicycled to the U.C. library, pulled the old journal off the shelf. "The Einstein formula jumped out at me," Beckmann said. "I was dumbfounded."

When I spoke to Beckmann more recently at the Boulder hospital he said in a faint voice: "Einstein is dead. But it will take decades to bury him." ❐

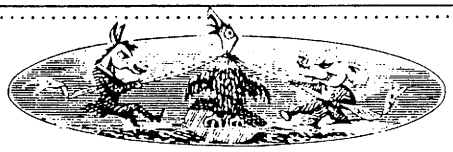
Frankly, hitherto astrology never fetched me. It had been my view that the arrangement of the planets overhead would hold about as much influence on my fate as an overhead cloud, and certainly less than an overhead bird in the final stages of digestion. Yet now I am beginning to weaken. Doubtless, many other Americans are too. Until recently the pundits were attributing Ronald Reagan's successful presidency to "magic." No less a political sage than Dr. Garry Wills, toiling in the pages of *Time* magazine, attributed the President's success to "magic." So now we know the source of the magic. Why all the surprise?

In the end, when the last gasp over Mr. Regan's revelations of White House stargazing sounds, my guess is that Mr. Regan's only effect will be a mild boom in the occult, and I take it he had higher ambitions than that. His problem in attempting to denigrate the President is that the President is a success. In fact, Ronald Reagan has presided over the first successful presidency since the 1950s. Now as he teeters through his eighth and final summer in the White House and the sniping begins, it is instructive to recall that he is the first President since Eisenhower to reach such a point and the only one in history to achieve it at the age of 77.

Some of his early accomplishments are now beginning to tarnish. His policy in Central America is in a dismal condition. He had rehabilitated the prestige of the presidency, but that prestige is now somewhat reduced. Yet in both cases the responsibility for these problems has to be borne at least in part by others: in Central America by the congressional Democrats who thwart his policy with no better policy to offer; in his entourage by those who have no honor. When the historians contemplate the prosperity and peace of the Reagan years, they are going to have to confront one fact: Ronald Reagan was President during that peace and prosperity.

Donald Regan, of course, is an integrate. If he felt frustrated by Nancy Reagan he had the honorable alternative of quitting. He could have written his book for the historic record but he should have had the decency of earlier disgruntled appointees such as James A. Farley under FDR and Sherman Adams under Eisenhower. He should have waited until his benefactor was in retirement; and then he might have practiced the restraint that others in his position have shown in the past. But he could not. As the poet wrote, Don Regan has demonstrated all the attributes of a dog save loyalty.

CAPITOL IDEAS



BECKMANN VS. EINSTEIN

by Tom Bethell

After Howard Higman's conference at the University of Colorado ("Boulder's World," *TAS*, June 1988) I went up into the Rocky Mountain foothills to see my old friend Petr Beckmann, who lives in a mountain eyrie with his wife Irene, two black Labradors, an A.B. Dick 360 printing press, science books and journals, and a mass of publishing paraphernalia. John McCarthy, a computer-science professor at Stanford, calls Beckmann "the I.F. Stone of the right," but that is not quite on target. Beckmann is part libertarian (but he considers most libertarians too left-wing), part Randian (too much of a cult there), and wholly anti-Communist. Since 1973 he has published *Access to Energy*, a "Pro-Science, Pro-Technology, Pro-Free Enterprise Monthly Newsletter," for about 3500 subscribers. Every day he bicycles down into Boulder to pick up his mail—sixteen miles round trip, vertical climb of 1100 feet on the way back—which is sufficient exercise for a 63-year-old man with sixteen screws in his shin bone (bicycling accident in September 1986).

Apart from putting out his newsletter (a marvelous read every month), Beckmann writes books and publishes them himself under the imprint of Golem Press. *The Health Hazards of Not Going Nuclear* has sold 50,000 copies since he published it in 1976, and *The History of Pi* has sold well, too. But the book that interested me and that I wanted to discuss with him was published only recently—*Einstein Plus Two*, a critique (perhaps a demolition) of Einstein's special theory of relativity. He spent four years writing it, but he had worked on it sporadically for decades, conducting some experiments relevant to the theory while teaching at the University of Colorado.

Beckmann told me that he is confident there is a fundamental error in Einstein's theory. His book presents a different theory, giving results consistent with all known experiments, including those most recently conducted with lasers. Beckmann's theory also explains two further phenomena which Einstein's theory cannot derive—the quantization of electron orbits, and the Titius-Bode Law, describing the orbits of all four known planetary systems (the Solar System and the moons of Jupiter, Saturn, and Uranus).

We went out for a walk and Beckmann told me a bit about himself, occasionally giving orders in Czech to one or another of his dogs. He was born in Prague in 1924, and, because his father was categorized as politically endangered (both his parents were Communists, as well as Jewish), he and his mother were transported as refugees to England in 1939. He spent World War Two in England, enlisted in a Czech squadron of the Royal Air Force, and serviced the then secret radar project. He so treasures his wartime memories of England that he doesn't want to go back and discover that victory was won only that Punk Rock might triumph.

In 1945 Beckmann returned to Czechoslovakia, received a Ph.D. in Electrical Engineering from Prague Technical University, and then a Doctor of Science degree from the Czechoslovak Academy of Sciences. In 1963 he was invited by the University of Colorado to be a visiting professor; he defected to the U.S. the following year, and thereafter he taught electrical engineering at Boulder until his retirement in 1981. He has published more than 60 scientific papers, mostly devoted to electromagnetics and probability theory.

During his eighteen years at the university Beckmann saw a tremendous decline in higher education, beginning with the Vietnam war, the slide continuing to this day. "England in 1939 was nowhere near as far gone as the U.S. is today," he said with characteristic pessimism. Moreover, "Hitler had very few sympathizers," unlike the Soviet leadership today. He believes the general deterioration of morale in the U.S. will continue "until we are hit over the head with a stick." What that stick will be he does not know, but one possibility is "the Soviet Union being taken over by the military."

Beckmann told me that he had doubted Einstein's theory ever since he was first taught it. It was true, he conceded, that many "nuts" attack Einstein, but a fair number of respectable scientists have long questioned the theory as well, among them Albert A. Michelson of Michelson-Morley fame. Beckmann said Einstein's special theory should not be called a theory "of relativity," for that is not what characterizes the theory. The postulate of relativity was stated by Isaac Newton in the *Principia* and Beckmann considers it uncontroversial. According to it, if one object is moving in relation to another, there is no "privileged position" in the universe permitting us to decide which is moving and which is at rest. The laws of physics apply impartially, whether you decide one is moving and the other at rest, or vice versa.

It is Einstein's famous second postulate that Beckmann challenges, the claim that the speed of light is a constant, whether or not the observer is moving in relation to the light source. As Einstein famously claimed, two observers, one moving toward and another away from a light source, will

Tom Bethell is The American Spectator*'s Washington correspondent and a media fellow at the Hoover Institution. A collection of his essays,* The Electric Windmill, *was published by Regnery Gateway this spring.*

both measure the light as moving toward them at identical speeds. Beckmann dissents. His rival claim is that the velocity of light is constant with respect to the gravitational field through which it passes. Light from a distant star, for example, will travel at one speed in its local gravitational field, increase as it moves out into space, then slow down again as it approaches the sun, and then travel at a slightly different speed as it moves into the gravitational field of the Earth. Light, in fact, should be thought of as a disturbance of the gravitational field, just as sound is a disturbance of the air. "Like waves on the water of a stream flowing into a river and into the sea," Beckmann writes, "light travels with different relative velocities through a vacuum in the terrestrial field, through that in the solar field, and through that of the fields that lie beyond."

As can be shown by simple geometry, Einstein's claim of a constant speed of light, whatever the motion of the observer, leads directly to bizarre results, which in turn are resolved when space and time are distorted accordingly by what is known as the Lorentz Transformation. These distortions are themselves dependent on the velocity of the observer. To a fast-moving body, other bodies shrink, put on weight, and age more slowly! The calculations used to alter space and time along these lines precisely offset the geometrical discrepancies that arise when you assume an invariant velocity of light.

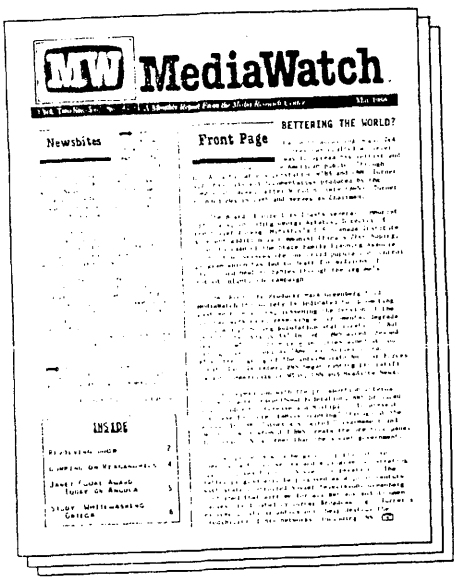
"When I run, I feel a wind, but not one that will make a windmill turn," is the dramatic opening sentence of *Einstein Plus Two*. "A physicist who *falsely* assumes that the effect producing velocity (that makes the windmill turn) is that with respect to the observer, but *correctly* applies the relativity principle, will expect the windmill to turn when he is running. The experimental evidence will contradict his expectation, and he can then either abandon his false premise, or he can so distort space and time that the observer's motion produces two exactly equal and opposite forces on the windmill, keeping the mill motionless as observed. The Einstein theory, in effect, takes the latter road; but I believe the laws of physics . . . must hold regardless of any observer, who should do nothing but observe."

Space and time are our most fundamental "givens," and velocity (space divided by time) is derived from them. Beckmann likens the assumption that the derivative (velocity) is more basic than the fundamentals (space and time) to the contortions of a man who attempts to reconstruct the ground floor of his house, dwelling undisturbed on the second floor as he does so.

I asked about Einstein's famous formula equating mass and energy ($E = mc^2$). Had this not been demonstrated by the atom bomb? The formula is "perfectly correct," Beckmann replied, "but you can derive it from universally accepted principles of electromagnetism without distorting space and time." In effect, it has nothing to do with Einstein's theory. Physicists before Einstein came very close to deriving the formula—some say Henri Poincaré did.

What about the oft-repeated story of the advance of Mercury's perihelion (the orbital point closest to the sun)? A 43-seconds-of-arc-per-century discrepancy (from the result predicted by Newton) had been discovered in 1880. Supposedly Einstein's theory "predicted" this. "Einstein's theory accounted exactly for this [43-second] residue," Bertrand Russell wrote in *The ABC of Relativity*.

Beckmann said he could hardly believe the way history had been distorted in the semi-official version of Mercury's perihelion. What was later to be known as Einstein's formula (explaining Mercury's orbit) was discovered and published in 1898, seventeen years before Einstein, by a man named Paul



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Gerber, who was probably a high-school teacher in Stargard, Germany. Using classical, not Einsteinian physics, and the assumption that gravity is not instantaneous (as Newton thought) but propagates with the velocity of light, Gerber derived Einstein's equation exactly. By contrast Einstein used a complex trick bag of gravitational tensors and Riemannian geometry. Yet Gerber is forgotten.

Is there not something wrong with a theory that gets you to the right place (the explanation of Mercury's orbit) by a complex route, distorting space and time *en passant*, when you can arrive at the same destination by simple methods?

Likewise the Michelson-Gale experiment of 1925 (not to be confused with Michelson-Morley) demonstrated an optical effect that is immediately explained as illustrating the different velocities of light along different latitudes of the rotating Earth (the Earth's gravitational field does not rotate *with* the Earth). Michelson used three lines of high-school algebra and classical physics. Einstein bent space and time with tensor calculus to get the same result.

Another famous experiment that supposedly confirmed Einstein was the demonstration (at the time of a solar eclipse in 1919) that light rays from stars are bent when they pass through the gravitational field of the sun. But such refraction is exactly what would be predicted if the velocity of light varies as the gravitational field changes. In order to explain the light path observed in 1919, said Beckmann, you do not need Einstein's complications—only the principle that light travels along the path that gets it from A to B in the shortest time (Fermat's Principle).

The great problem in testing the relative merits of Einstein's theory and his own, Beckmann said, is that all or nearly all the evidence confirming Einstein is generated by experiments in which "the observer is nailed to the gravitational field of the Earth." And in all such experiments, Beckmann and Einstein would expect to get the same results. In principle, Beckmann says, there are experiments that can decide between the two, but at present it is not possible to measure this difference, because measuring instruments can still only be moved at an insignificant fraction of the speed of light.

"I am not so naive as to think that the first attempt to move the entire Einstein theory *en bloc* onto classical ground will turn out to be perfectly correct," Beckmann writes in his preface. But he told me that he was nonetheless confident that Einstein's theory is wrong. Meanwhile, he said, he was beginning to worry that "they'll fail to crucify me." He would rather have his errors exposed, if such exist, than be ignored. A handful of physicists have taken note of Beckmann's effort, however, among them Howard C. Hayden, an associate professor of physics at the University of Connecticut.

"Frankly, I think he's on to something," Hayden told me over the telephone. He said he would recommend Beckmann's book to anyone interested in the logical structure of physics. Hayden also said he was submitting an article "about one aspect of the book" to the journal *Foundations of Physics*. "Beckmann asserts that the speed of light has never been shown to be a constant," he said. "At first I thought this must be wrong, but I have since reviewed the literature and I have not found one paper that would show him to be incorrect. The constancy of the speed of light has not been demonstrated experimentally. The simplest explanation for all the speed of light experiments is not Einstein's, it's Beckmann's, and he gets the results normally attributed to relativity effects without the use of distorted space and time."

(Einstein Plus Two *may be ordered from The Golem Press, Box 1342, Boulder, Colorado, 80306, $36 ppd.*)

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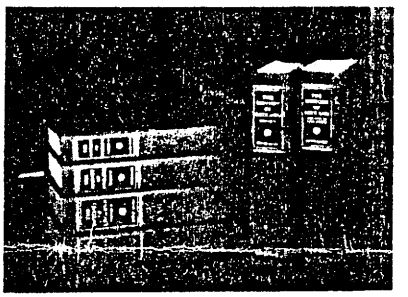

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Yes, they contradict Einstein. But not the experimental evidence.

Who?

The authors who publish in *Galilean Electrodynamics.* A rebel journal that spurns fashionable orthodoxy and puts truth above authority.

Published by ignorant cranks?

No; by scientists who have attained high academic rank and international renown in their fields: *Thomas G. Barnes*, Professor Emeritus of Physics, University of Texas at El Paso; *Howard C. Hayden*, Professor of Physics, University of Connecticut; *Prof. Pavel F. Parshin*, Head of Physics Dept., Academy of Civil Aviation, St. Petersburg, Russia; *C.K. Wh-Whitney,* Visiting Industry Professor, Tufts University, *Petr Beckmann* (editor and publisher), Professor Emeritus of Electrical Engineering, University of Colorado and Fellow, I.E.E.E.

Galilean Electrodynamics is published bimonthly. Volumes 1 (1990) and 2 (1991) have been published.

What you (almost) missed :

Volume 1 (1990):

P. Beckmann: *The Double Slit Paradox*

Unlike a wave, a particle does not split into parts, attracts and repels other particles, and does not suffer natural attenuation by dispersion. Yet the Duality Principle papers over these differences and makes a particle interfere with itself. There is a simpler and more rational way to explain what goes on in electron diffraction — and it needs no new hypotheses.

R.L. Carroll: *The Role of Inertial Force in Energy Exchanges*

Where did the potential energy of one body in the field of another come from? What happens to that energy when an attracted body is released and then stopped?

H.C. Hayden: *Experimentum Crucis*

No one has ever shown the velocity of light east and west on the rotating earth to be constant. Available evidence strongly suggests that it is not. A crucial experiment on the point is now in progress. Can you predict its outcome?

H.C. Hayden: *Light speed as a function of gravitational potential*

In a 1987 book, Beckmann proposed that the velocity of light is constant with respect to a constant gravitational field through which it propagates. Using no more than the conservation of energy and Fermat's principle, Prof. Hayden derives the verified formula for the bending of light rays in the gravitational field of the sun.

P. Beckmann: *Light Path in a Gravitational Field by Hayden's Formula and Fermat's Principle*

Mathematical purists might object that Hayden's derivation above takes a limiting approximation before integration. But an exact formula can be derived by variational principles from the Euler-Lagrange equation.

J.P. Claybourne: *Experimental Data and Simultaneity*

Events taking place simultaneously in one inertial frame cannot be simultaneous in another, and the time of an event in another inertial frame depends on the observer's coordinates, says Einstein. But that's not what the measurements by satellite clocks say.

W.L. Shimmin: *An Overlay of Fieldlets*

Consider the magnetic field of a moving particle and its force on another moving particle. Add all the fields of such individual "fieldlets" in a large mass of particles and the resulting macrofield is the standard with respect to which the velocity of light is constant.

F.J. Müller: *Unipolar Induction Experiments and Relativistic Electrodynamics*

The result is the same whether you move the magnet or the wire, said Einstein in his classic 1905 paper. But Faraday in 1831 was the first of many to show the unipolar effect: a cylindrical magnet rotated about its long axis will not induce a voltage in a circular disk with the same axis; yet when the disk is rotated, a voltage appears. The Einsteinian explanation seeks refuge in the rotational and therefore accelerated motion of the disk or magnet. But the experiments with a translational, uniform velocity of the magnet reported here destroy that defense.

P. Beckmann: *Entrainment by Non-Refractive Media*

If the Beckmann assumption were true, said the critics, then a light ray passing from one gravitational field to one moving with respect to the first (e.g., the planets in the sun's field) would be bent (refracted) at the boundary. Not so, he answers, for in the Galilean velocity addition, at least one of the media must by definition be treated as anisotropic, and everything, including aberration, works out exactly as observed.

H.C. Hayden: *A Possible Explanation of the Edwards Effect*

A 1976 paper in the *Physical Review* showed that, inexplicably by any conventional theory, a potential proportional to the square of the current appeared on the surface of a superconducting wire. However, if the velocity implied by the Maxwell equations is not that with respect to the observer, but with respect to the field transversed by a moving charge, the explanation is simple and accurate.

T.G. Barnes, H.G. Slusher: *Space Medium Theory applied to Lunar and Stellar Aberration*

If there is a medium surrounding each heavenly body with respect to which the velocity of light is constant, can lunar and stellar aberration be explained? Very easily.

J.P. Claybourne: *A New Analysis of Time Dilation*

Time dilation as appearing in experiments with muons, clocks transported round the globe, and satellite measurements are explicable by the Lorentz approach to time dilation without requiring the Einsteinian constant velocity of light.

R.L. Carroll: *The Nature of Space*

What is space? Not a mathematical infinite emptiness, but something where the four-dimensional wave equation is valid due to the presence of matter. This leads to a potential in the form of a rapidly converging power series in $1/r$. Its analysis leads to force functions with velocities determined by the local field surrounding matter, and not by any observers.

P.Beckmann: *Electron Clusters*

A cluster of 10^{10} electrons in a sphere with a 1 micron radius? By conventional theories, Coulomb's repulsion would explode it. Yet for a decade a Texas research company has been producing such clusters and using them in applications. The same electron oscillations, derived from the Maxwell equations that explain the double slit paradox and refute the Einsteinian version of the Relativity Principle provide the force that will, under the conditions met here, overpower the Coulomb repulsion.

H.E. Wilhelm: *Galilei-Covariant Field Equations*

Nobody denies that the Maxwell equations are Lorentz-covariant. But if the effect-producing velocity of charges is the one with respect to the traversed field, this covariance becomes an irrelevant curiosity. Alternatively, as physicist H.E. Wilhelm, Professor of Materials Science at the University of Utah, shows here, the Maxwell Equations can be generalized so as to contain an explicit velocity w of an inertial frame with respect to a substratum; and for $w \to 0$ this system reduces to the ordinary Maxwell equations.

D.L. Bergman, J.P. Wesley: *Spinning Charged Ring Model of Electron Yielding Anomalous Magnetic Moment*

"The structure of the electron is still a mystery," says an article on atomic structure and spectra in the *McGraw-Hill Encyclopedia of Science and Technology* (1982). Is there a model that will explain the electron's mass, charge, spin and magnetic moment, including anomalous moment? Yes, there is, says this paper.

H.C. Hayden, C.K. Whitney: *If Michelson-Morley, Why not Sagnac and Michelson Gale?*

Quite possibly you have not heard of the most grandiose optical experiment on the speed of light: the 2,000,000 sq.ft. interference loop set up by Michelson and Gale in Illinois in the winter of 1923-24. Why not? Because it is rarely mentioned in physics books — presumably because Michelson explained it in two lines of high-school algebra, whereas today's orthodoxy needs General Relativity to explain the result. According to GRT, the shift (yes, there was one) is proportional to the area enclosed by the interference loop, which is zero in Michelson-Morley. But is it? Locally, yes. But when you consider all of the earth's orbit round the sun . . . this paper reveals unsuspected contradictions.

D.H. Deutsch: *Reinterpreting Planck's Constant*

The dimension of Planck's constant are those of action, and the Principle of Least Action is one of the backbones of modern physics. But how sturdy is this backbone? The dimensions are also those of angular momentum; and many difficulties disappear while new possibilities open up when this principle is replaced by the conservation of angular momentum.

Volume 2 (1991):

P. Graneau: *Estimating the strength of water arc explosions*
There is no longitudinal magnetic force on in the direction of a current (charge velocity) says the Lorentz force. A number of experiments, including water arc explosions, say otherwise.

R.L. Carroll: *Superconductivity and electron viscosity*
Applying quantum theory to fluid mechanics, this paper shows that under certain circumstances electron pairing and high currents in filaments should occur; bismuth at room temperatures cannot be far from superconductivity.

D.M. Drury: *Aberration and the electric force on a moving charge.*
The non-relativistic electric force on a moving charge predicted by the Beckmann theory leads to an additional, aberrant component of the Lorentz force, which should be detectable. Experimental verification appears feasible and an experiment is proposed.

R.J. Heaston: *Einstein's great oversight*
In deriving the gravitational field equations, their author adopted the dimensional simplification of setting $G = c = 1$, which did not lead to erroneous results, but caused him to miss a superforce and its ten crucial effects.

C.K. Whitney: *A Gedankenexperiment with relativistic fields*
The retarded potential of a moving charge leads to effects which are, to say the least, counterintuitive.

D.L. Bergman: *Spinning charged-ring model of elementary particles*
The spinning charged-ring model that yields correct characteristics for the electron in the paper by Wesley and Bergman in vol. 1 is equally successful for the proton, positron, and antiproton.

B.I. Peshchevitskiy: *The Lorentz transformation and its reference frames*
The Lorentz transformation describes reference frames in which the time coordinate is decreed by convenience, not derived as a property of nature — a fact confirmed experimentally by synchronization satellites.

J.C. Curé: *The perihelic rotation of Mercury by Newton's original method*
In the *Principia*, Newton found that the line of apsides of the planets must rotate, but due to his use of the geometric method, this has long remained unknown. Using his method with contemporary mathematics, the result is slightly better than Gerber's (who preceded Einstein with the same formula by 17 years).

L.A. Pobedonostsev, P.F. Parshin: *Experimental investigation of a relativistic effect*
The transversal Doppler effect is investigated by direct measurement of high-velocity hydrogen ions at 77° and 257°. It was discovered that residual gases and oil vapors in the operating space and the resulting averaging over velocities throws doubt on the interpretation of the Ives- Stilwell experiment and its modern repetitions.

T.G. Barnes: *Resonance optics for detection of rotation and translation*
A proposal for a laser speedometer that can be used to test the STR.

H.C. Hayden: *On a recent misinterpretation of Sagnac's experiment.*
A recent paper invoking Sagnac's experiment as a proof of the GTR is shown to be both historically and physically untenable. Its classical explanation is both simpler and more general.

H.C. Hayden: *Yes, moving clocks run slowly, but is time dilated?*
The difference lies in the symmetry. According to Einstein, two observers, each in a different inertial frame, each see the clock of the other running slow. But if the slowing is caused by motion through the gravitational field, all observers see the same moving clock running more slowly than the one stationary in the field. The evidence gives more support to the second alternative.

C.I. Mocanu: *The paradox of Thomas rotation*
When the Lorentz transformation is used in 3 space dimensions (instead of the "for simplicity" single space coordinate), the relativistic composition of two general velocities fails to satisfy the commutative law. This was patched up in the 1920s by Thomas rotation. That may cure the kinematics, says this paper, but the electromagnetic equations go bust.

E. Eitelberg: *What is the amount of matter?*
The $E=mc^2$ can be derived in a variety of classical ways, but what is it that corresponds to the quantity of matter? At first sight, the sum of neutral (gravitational) and electromagnetic mass, but there are difficulties.

B.I. Peshchevitskiy: *The invariance of discrete counts*
The least one can ask of a self-consistent theory is that the discrete number of events counted in one inertial frame agrees with those counted in any other. The SRT does not fulfill that condition.

D.F. Roscoe: *A geometric representation of inertial process*
There is more than simply a definition to the equivalence of inertial and gravitational mass. This mathematically sophisticated paper argues that gravitation is a particular case of inertia.

D.L. Carroll: *The toroidal electron*
The model of an electron as a spinning charged ring is here derived from first principles.

F.Twiss: *Limitations on viewing distant astronomical objects.*
If there was a big bang and the velocity of light cannot be exceeded, how far can we see into the universe? Not as far as orthodoxy would have us believe.

D.F. Roscoe: Gravitation as an inertial disturbance
Continuation of the paper above reveals a deeper significance of gravitational and inertial mass.

D.J. Savage: *The Tau Potential*
Proposes a new equation for mass in which motion relative to the locally dominant gravitational field determines the changes in mass. The theory results in some practical, startling predictions of the energies the LEP accelerator, when built, will be able to handle.

S. Dinowitz: Super-relativistic dynamics
A new definition of mass is proposed in which motion relative to the locally

Volume 3 (1992)

F. Winterberg: *Wheeler's geometrodynamics and the zero point vacuum energy*
Wheeler's claim that the zero point vacuum energy of quantum gravity of a certain density can be compensated by negative gravitational energy in-between Planck length fluctuations is shown untenable.

Xu Shaozhi and Zu Xiangqun: *A reexamination of the Lorentz Transformation*
Using a generalized transformation of which the LT is a special case, the authors found contradictions in the latter. However, discussion in the Correspondence column showed the argument to be flawed.

P. Beckmann: *Sagnac and gravitation*
Contrary to the claims of some opponents of relativity, the GTR explanation of the Sagnac effect is logically clean, even though it is cumbersome and complicated compared with classical physics.

C.M. Hill: *Maxwell's equations in moving coortdinates*
For the propagation of an electromagnetic wave through free space, Maxwell's equations are applicable only if the wave velocity is constant. This constraint is removed here.

H.C. Hayden: *Distinctions between Galilean and Einsteinian physics*
There are plenty of such distinctions, but not a single one that has been flawlessly resolved by a crucial experiment.

H.E. Wilhelm: The dielectric Cherenkov effect
A new interpretation is given to the Cherenkov effect by means of the Galilei-covariant Maxwell equations.

L.A. Pobedonostsev: *Experimental investigation of the Doppler effect*
Further measurements of the experiment reported in vol. 2 under changed conditions are reported. Th eresult is the same as before: the "transversal Doppler effect" is due to non- uniform velocitites of the ion sources; there is no such effect inherent in the light wave motion.

T. Chang: *Imaginary charge and gravitational- electric space*
Great simplification can be achieved by regarding gravitational mass as imaginary electric charge.

J.W. and J.F. McAlister: *A mechanical test of the equivalence principle*
An experimental report on an oscillator that does not run in the same way when activated by gravity and an equivalent force in the horizontal plane. No explanation wa offered, an none of the numerous tries in the correspondence columns has been successful.

D.M. Drury: *Lorentz's Galilei-invariant form of Maxwell's equations in free space*
A charge in an electromagnetic field is subject to the Lorentz force which can be made Galilei-invariant.

T.E. Phipps, Jr.: *Potier's principle: a trap for unwary etherists and others*
Potier's principle, enunciated in 1874, makes it impossible to test the speed of light expressed as the sum of c and the scalar product of the propagation vector and some convective velocity.

J.G. Valverde: *Gracitational redshift revisted*
It is sugegsted that the gravitational redshift occurs not on the trip of light from source to destination, but during the emission of the photon at the energy level affected by the gravitational field.

P. Graneau: *heavy-water-arc gun for impact fusion*
Considers the possibility of D-D nuclear fusion by using the impact of heavt water droplets fired from water-arc guns.

E.I. Shtyrkov: *Cosmological Redshift and light velocity in vacuum*
The redshift need not be a Doppler effect, but may be due to a very slight attenuation term in the wave equation, thus taking care of Oort's paradox, too.

S.A. Tolchelnikova: *A new way to determine the velocity of the solar system*
If the speed of light depends on the motion of the solar system, then it can be uncovered by careful observation of the satellites of the planets in the solar system.

H.C. Hayden: *Was Edwards contradicted experimentally?*
The Edwards effect (vol.1) is one of the items of experimental evidence supporting the Beckmann theory and contradicting the SRT. An experiment allegedly contradicting the effect is here refuted.

D.T. MacRoberts: *The "Time Dilation" of mesons re-esamined*
The meson-halflife experiments need not be attributed to time dilation, but can at least as well be accounted for by their motion through an ether entrained with the earth.

S. Bertram: *Faraday's and Ampère's Laws*
Two potentials associated with a moving charge are derived; when the charges are moving, they propagate with the velocity of light relative to a stationary point,

C.K. Whitney: *What's wrong with standard relativistic fields?*
A further analysis of the Liénard-Wiechert formulation of the field of a moving charge leads to contradictions with SRT.

A.K.T. Assis: *On the mechanism of rail guns*
Not electromagneticmomentum, but the Ampère force is what propels the missile fired from a rail gun.

B.I. Peshchevitskiy: *Relativity theory: alternative or fiasco?*
The SRT introduces a hidden third postulate: that of local time in the reference frame. The alternative to the Lorentz transformation is not the Galilean transformation, but a transformation between unequally privileged frames.

F.M. Kanarev: *The role of space and time in scientific perception of the world*
A theorem on teh unity of space and time is derived which shows that non-Euclidean space must lead to physically untenable results.

T. Chang: *Multiple concepts of time in flat and curved space*
Einstein's definition of time is not the only one in flat space. Multiple concepts of time and the relations between them are discussed.

R.L. Carroll: *The nature of time*
It is shown from the conservation of energy and other fundamental laws that there is no validity in time dilation, but there is a reduction of the internal emergy of an accelerated object, and hence the slowing of periodic processes.

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A NOTE ON THE SPEED OF LIGHT

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SUMMARY. - This note examines the hypothesis that the speed of light depends on the strength of the gravitational field: the weaker the field, the greater the speed. It is argued that no evidence exists which would prompt one to dismiss this hypothesis out of hand. An experiment is proposed that would check the validity of the hypothesis.

PACS 04.50 - Speed of light and gravitation

ECE/642, September 1984

INTRODUCTION

None of the experiments that have been carried out to determine a precise value for the speed of e.m. waves have ever asked the question whether the speed was a function of the strength of gravitation. In all these experiments[1] the gravitational field has been more or less uniform. Radar ranging experiments that have been performed to check the so-called fourth test of the general theory of relativity have indeed shown that a delay is introduced in the return time of radar echoes when the e.m. waves pass close to a massive body but this has been interpreted to be a result of the warping of spacetime. This warping is not taken to cause any change in the speed of light because one assumes that clocks slow down in a gravitating field.

There exist several puzzling aspects of the standard picture of matter and motion, i.e. gravitation. For example, the theory of relativity was supposed to have banished absolute space, yet astronomers can now talk of the absolute speeds of the earth and the sun through the background microwave radiation. The speed of light is the upper limit of motion according to the relativity principle, yet for black holes inside the event horizon space flows faster than the speed of light.[2] To an object that has just entered a black hole, the radiation from the rest of the universe gets extremely blue-shifted. The events in the outside world appear speeded up and in fact the entire future of the universe flashes instantaneously. Does this mean that objects do not actually reach the singularity once they have crossed the event horizon? Also if black holes were sufficiently numerous then the rays from the stars should get blanked occasionally in our observations. Yet this

does not appear to happen. There is also the problem of accepting singularities in a scientific framework, especially when it violates conservation laws, as black holes do.

Can we say that we do not know how gravity works when distances become very small as would be true for compressed matter? Is it then that the scenarios being analyzed are contrived and pure speculations? Perhaps, what we need are more signposts, by way of experimental data, to be able to find our way. This note is an attempt at generating evidence that could become one such signpost.

A HYPOTHESIS

In view of the difficulties outlined above, we believe there exists a case for performing experiments on the measurement of speed of light in gravitational fields of different strengths. In particular, we would like the following hypothesis to be checked: the speed of light in vacuum depends on the strength of the gravitational field; the speed is lower in stronger fields.

Note that this hypothesis is not at variance with the special theory of relativity, which does not consider gravitation at all. Furthermore, previous experiments on speed of light could not be used to shed any light on the hypothesis, since these experiments were not designed to look for changes in the speed of light.

Clearly the implications of such a hypothesis, if proved correct, would be considerable. The time delay of radar echoes is consistent with the hypothesis. Without the necessity of the apparatus of the general theory one could conceivably explain the correct value of the bending of starlight by the sun, as well as the other effects that are taken as evidence favoring Einstein's general theory.

Such a hypothesis would help avoid the difficulty of space collapsing with a speed greater than the speed of light within a black hole as well as other difficulties in the study of singularities. It also provides a bridge that may be useful to bring gravitation within the unification framework that has been successful in incorporating the other forces.

A PROPOSAL FOR AN EXPERIMENT

Whether our hypothesis should be given any consideration would be clear if the following experiment is performed. An experimental set up is designed to measure the speed of light, and then it is transported to a satellite or a high altitude aircraft where the measurement is repeated. It would be helpful if the satellite or the aircraft were geostationary when the experiment was performed, so that the issue of clocks running at different rates for the two locations of the experiment could be eliminated. In a certain sense the experiment would determine the effect of gravity on the rate of clocks.

Another experiment that can be performed terrestrially is where the delay in propagation between two phases of a laser beam is compared. One phase is an arm parallel to the earth and the other phase is an arm vertical to the earth. If the arms are switched and the phase difference changes, that could be interpreted to imply different propagation speeds.

NOTES

(1) C. W. Misner, K. S. Thorne, J. A. Wheeler: Gravitation (S. Francisco, 1973).

(2) S. W. Hawking, G. F. R. Ellis: The Large Scale Structure of Space-time (Cambridge University Press, 1973).

ACCESS TO ENERGY

A Pro-Science, Pro-Technology, Pro-Free Enterprise Monthly Newsletter

August 1993 (Vol. 20, no. 12) **Box 2298, Boulder, Colorado 80306** Copyright © 1993 by *Access to Energy*

Goodbye, dear readers

I wish I knew how to impress it on you so deeply that you will never forget it: *It is the torch, not the torchbearer, that matters.* The torch, the Truth, shines on; the old torchbearer recedes into the darkness.

Let it shine on through the Green stench that is enveloping us ever more closely, let it throw light into the black night of ignorance, let it prevail over the dark forces of tyranny and stupidity. Keep it flying high!

I would nevertheless like to muse a little over the 20 years of *Access to Energy.* I feel satisfaction for having kept my promise of never accepting any grants, contributions, or anything else but subscriptions. If I am not good enough, I said in vol. 1 no. 1, let me go under. Free marketeers don't panhandle. If the amount was small, I would tag it onto the subscription. If it was large, as it was in several offers, I would reject it outright. Clean independence is worth more than money, and it provides a check on how good you are.

In the newsletter world any renewal rate over 50% is considered excellent. Many newsletters have a renewal rate close to zero. They spend their budget on advertising and sell it to a different set of subscribers every year. For the last 8 years or so, *Access to Energy* did not spend a solitary cent on advertising. The renewal rate very rarely dropped below 80% and usually stayed above 90%. New subscriptions made up for the dropouts, and for the last 8 years or so the circulation held steady.

Why? In part, because I did not play by the rules. Every newsletter manual will tell you to "conceal your sources." You know that I carefully documented every single source.

To get at the truth, it is well to go to the original sources. What do Dan Quayle, Niccolo Machiavelli and Friedrich Nietzsche have in common? A reputation ruined by night club comics and half-learned dimwits. Quayle, presented as an infantile bungler, was in fact the only strong anchor in a weak, unprincipled and hollow administration. Machiavellian means cynical, dishonest, scheming, surreptitious, conspiratorial. But Machiavelli's *The Prince* (1527) is none of these; it is a sober assessment of the contemporary systems of government and a plea to unify Italy. And Nietzsche's superman, allegedly the ideal Nazi? Nietzsche was one of the most impressive philosophers. He was an internationalist, and his superman was the ideal man. He was Swiss, but if there is one nation for which he felt an ill-disguised contempt and disgust, it was the Germans, whom he despised for their slavish obedience to authority. Some Nazi!

The search for truth begins at the sources. Truth is what agrees with experience after all possible alternatives have clashed and have been shown unviable.

So what was the sense in fighting the charlatans for 20 years, they talking to 50 million for hours every night, I talking to 6,000 on 4 pages once a month? The demon inside me just said "Don't let them get away with it." But after 20 years it suddenly had an answer for me. "Do not count the heads; weigh them!" The birdbrains who listen to mental cripples like Tom Brokaw & Co, taking a swig from their six packs whenever the lies are interrupted by the incredibly stupid melange of foods, soaps and chewing gums, have been there during all the ages. They are the cowards, and slavish parrots only a little more stupid than Brokaw and the other charlatans themselves. They will never do anything except in a crowd with a mob mentality. But also throughout the ages there were others, the ones who knew better: the mathematicians behind thick cloister walls, the Great Navigators, all those who brought about the Renaissance and raised the shining torch of truth. The riff-raff of dim-witted parrots would sometimes lynch them, but they could not extinguish the torch.

Keep the torch of truth shining bright and high!

Dear readers, I would like to take leave of you with the words of a great Czech, Jan Hus, a religious reformer 100 years before Luther. He voluntarily went to defend his views before the Ecclesiastic Council in Constance (on the border of Germany and Switzerland), but the Council condemned him as an heretic and he was burned at the stake on 6th July 1415. In his last letter from his dungeon in Constance sent to his people ("via a good German") he wrote: *"Love the truth and be generous in letting everybody benefit from the truth!"*

STATE OF THE EDITOR

The last issue was written under great difficulties. Little did I know that right afterwards I would have to be admitted to hospital for yet another operation, kidney, blocked ureter, disgusting things. More weight loss, blood loss, now I can lift a Kleenex, but not much more. An internist and a urologist separately told me I was dying of cancer, but I have reason to hope that they may be wrong.

However, there was not a whiff of a chance in this past month, the most horrible of my life, in following the news, let alone clipping items for this issue. So I will make a virtue of necessity and celebrate the last issue under my editorship by writing about science, but not about energy. I am writing this on the loafer's schedule: a paragraph or two of writing, 2 hours of recuperation stupor. Perhaps I can make it in time even though I will not be able to print it myself. But then I had a blood preassure collapse, back to the hospital, More time lost, more strength lost. Please bear with me.

A LITTLE PHILOSOPHY OF SCIENCE

As indicated last time, Dr Howard C. Hayden, professor of physics at the U. of Connecticut, has convincingly shown that Einstein's theory of relativity leads to results contradicted by experiment.

Those are fighting words, and we will first go through some points that are not too clear to many laymen, and, alas, to many scientists. All physical theories must ultimately be anchored in experiment. It is their job to explain the available evidence as simply as possible.

The main point is this: When you test a theory by experiment, one thousand experiments will not prove it, but a single experiment will refute it. The reason is that the 1,000 experiments may be consistent with the theory, do what the theory predicted, support the theory, etc., but that is no proof that the investigated theory is the only one that does so. To the contrary, if the experiment shows the theory is wrong, there is no more to argue about (or ought not to be); the theory is dead.

Time and again it has happened that the correct predictions of a theory were so spectacular that scientists were lulled into complacency and accepted it as holy, only to find that the holy theory collapsed like any other that holds its own for a time. I have earlier given the example of the caloricum theory.

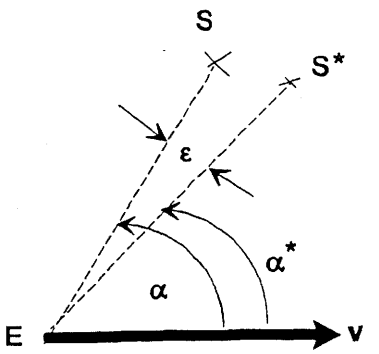
The fact that this progression toward more and more accurate truth takes place so slowly and by hairline breadths shows that we are on the right path. It is not that what we thought was a monkey turned out to be a rhinoceros, but that when we thought the monkey had 300,008 hairs, it proved to have 300,009.

Now this goes for all theories, but there is something additional that goes for the theory of relativity. A law like that of the conservation of energy, which rests on experiment like any other, has been demonstrated in thermodynamics, mechanics, optics, acoustics, wave propagation, atomistics, nucleonics, and even further removed subjects like chemistry and biology.

The spectacular successes and predictions of the theory of relativity have been very numerous; but over what breadth? The slowing of processes in moving systems (allegedly due to "time dilation") and elementary particle physics, plus a few, often disputed, scraps here and there. There has not, in the past, been a case of applying the theory to well defined macroscopic bodies with well defined velocities. Such a case has now been found and the Theory of Relativity has fallen flat on its face, as I will try to explain in a moment.

None of us is likely to know more about electromagnetics than Berkeley physics professor W. Jackson. Yet he has been lulled into the false belief that the Theory of Relativity is "proven" by experiments. You may not ever know as much electromagnetics as he does, but if you have understood what I had to say above, you are a fundamentally better scientist than he is.

A SWAN AND A STAR

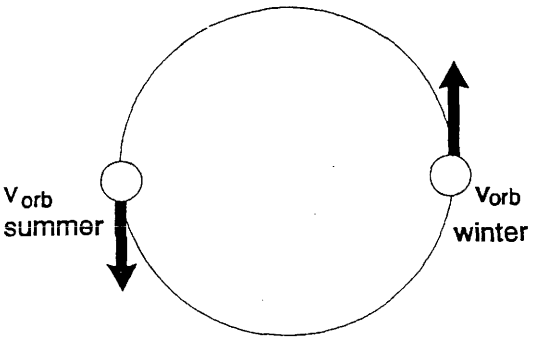


Consider a great big pool of water with no wind to make waves. *S* is the swan Sylvester swimming for his pleasure and making waves on the water. *E* is the ship Ebenezer steaming with velocity v (with respect to the water) commanded by Captain Ezekiel. The Captain can't see the swan because it is too far away, but he can measure where the waves are coming from. If he does so with respect to his own boat, clearly the velocity of the boat will cause them to arrive at a tilted angle because the boat is driving into the waves, just as if they had come not from *S*, but from *S**. The difference in direction between the true position of *S* and the seeming position *S** is called the aberration (angle) ε of S.

For swans and ships Einstein and everybody else is agreed on how to calculate the aberration ε. But now let *S* represent a star and *E* the Earth. Then the old classics, who believed in an ether carrying light not very differently from water carrying waves, calculated the aberration the same way. This "instantaneous" aberration turned out to be

$$\varepsilon = (v/c)\sin\alpha$$

where *c* is the velocity of light andand if sina really intinidates you, choose a star wit a $=90°$ and sinα, will disappear. . In any case, it



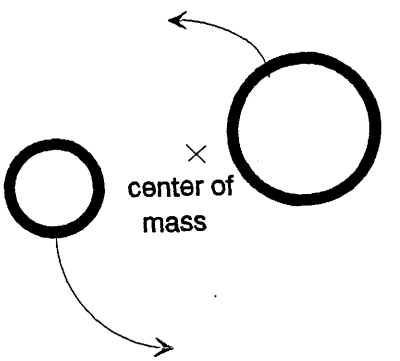
did not do them much good, because there was no way to measure it directly. Indeed, what would they compare the aberration to? There are no "non-aberrant" stars. What you see is what you get, and you do not know where the real source of light is. So what has been done since the 18th century (actually since 1690 by the great Danish astronomer Roemer) was to measure the angle of passage of a star through the meridian in summer and winter, when the orbital velocity of the Earth (30 km/s) was reversed and take the difference. The velocity of the star canceled out and left the result

$$(2v_{orb}/c)\sin\alpha$$

which agreed nicely with experiment.

But then came Einstein who said there is no ether, only moving systems (star at rest in one, Earth in the other) and relative velocity. He got the same formulas except that the v was the relative velocity of star and Earth. And that is where he was wrong.

DOUBLE STARS AND THE MISSING EVIDENCE



There are no "fixed" stars. They all have their velocities, but they are so far away they appear fixed in the same place. In any case, as far as we are concerned, their velocity is constant, so that on subtracting the summer from the winter aberration it will just cancel out.

But about half the stars in the sky, it is estimated, are double stars or binaries, with two stars orbiting a common center of mass. These stars do *not*, of course, have a constant velocity, and if Einstein were right, the relative velocity of each star and Earth would not cancel out during half a terrestrial year; a periodic component (period of the binary) would appear even in the instantaneous aberration. To make the effect observable, one must choose a binary with a very short period, comparable to the Earth's (one year). That means the two stars must be very close together, and that in turn means giant telescopes with a sufficiently strong resolving power. Such telescopes came into existence at a time when the Einstein theory was already well enthroned and explains why such investigations were not carried out earlier.

In any case, if Einstein were right, the increased aberration would be at least 20 times larger than the resolving power of modern telescopes. What is more, by contemporary automated

methods of scanning the sky, such a wildly larger aberration would register an "alarm" *even if they were not looked for.*

But there have been no such "alarms" from anywhere in the sky. No periodic components predicted by the theory of relativity have been observed.

Einstein was in error. His theory is dead, though it will take decades to bury it among the grieving hagiographers.

[What theory does explain aberration correctly? Mine, for example, of light having a constant velocity in the local gravitational field, but that is not the point here.]

NAILING IT DOWN

There is something that I for one, find somewhat dismal about astronomy beyond the solar system, and that is its inability to engage in independent verification. We all know about the Redshift, which is supposed to be the Doppler shift of an expanding universe that started with the Big Bang. But there are others who say it may not be a Doppler shift, and there never was a Big Bang. It all leaves one with a sense of ugly uncertainty.

But thank God, the failure of Einsteinian aberration in double stars does not belong to this group. There are thousands of double stars to choose from. Many of them can be observed by three different methods: optically, spectroscopically (the spectra of the components moving toward and away from the earth) and the laws of celestial mechanics. All three agree. For example, the star ζ in the constellation Sagittarius is a binary with a period of only 21.14 years. The stars are visible optically, their masses and velocities can be measured spectroscopically, and the celestial mechanics are in agreement, too. If aberration were dependent on the *relative* velocity of star and Earth, the aberration would be some 20 times greater than measured, and could not escape detection even if it was not looked for.

No Big Bang uncertainties here. No out for Einstein.

CHECKING IT OUT

The advice I usually give for checking out my statements, namely to confront my opponents with them, is useless here.

Not to mention the difficulties with which this whole discussion began, they will ridicule and mock you. The more intelligent among them will point out that the great majority of anti-Einsteinians are crackpots and nuts (true); that there have been many previous claims of refuting Einstein experimentally before (true again); but that all such attempts turned out to be flawed (and true for the third time).

So how do you check things out?

By looking at Einstein's original classical 1905 paper "On the electrodynamics of moving bodies." Here he makes two bizarre postulates, derives the relation between quantities in two uniformly moving systems (the Lorentz transformation), and in Sec. 7 deals with aberration and the relativistic Doppler effect in one swoop. Check out my story by asking the Einsteinians:

- Did Einstein (and thousands since) misapply the theory of relativity in deriving aberration in Sec. 7?
- If so, is the relativistic Doppler effect also wrong?

Don't let them befuddle you with talk and philosophy. The mathematics of Einsteinian aberration are fairly simple. Rub their noses in it. Then show that they yield a result contradicted by experiment.

You might also point out the limited scope of the Theory of Relativity. It differs from classical physics exclusively in the cases where the velocities of matter are commesurate with the velocity of light: That is for elementary particles and in astronomy. And only astronomy has well defined macroscopic bodies.

Hayden's paper will be published in the Sept./Oct. issue of *Galilean Electrodynamics* next month. If I live long enough, I will publish all of volume 4 (1993) as a paperback. Please do *NOT* buy it unless you are thoroughly familiar with all aspects of electromagnetics at the graduate level.

SO HE WAS RIGHT AFTER ALL

Something else momentous happened last month. The earth shook beneath the house of mathematics, which was buzzing with excitement such as it had not seen for — well, for more than 350 years.

After the death of one of the great mathematicians and physicists of the early 16th century, Pierre de Fermat (1601–1665), a book by the ancient Greek mathematician Diophantos was found among his possessions. The book is a well known treatise on solutions of equations in whole numbers.

In the margin, Fermat had written a note stating a deceptively simple theorem: *The equation*

$$x^n + y^n = z^n$$

has no solution in positive integers when $n > 2$.

"Of this," his note continued, "I have found truly wonderful proof, which this margin is too small to contain."

For $n = 1$ the solution is trivial; for $n = 2$, the solutions are the Pythagorean numbers such as 3,4,5 $(9 + 16 = 25)$ and for $n > 2$, said "Fermat's Last Theorem" or "The Great Fermat Theorem" or "Fermat's marginal note," no solution in positive integers existed.

Generations of mathematicians became obsessed with the proof. No one ever found a case proving Fermat wrong, but the proof was lacking. Various academies of Sciences offered prizes, a German nobleman who had spent his life vainly searching for the proof, left his fortune to the first to prove Fermat's Last Theorem. But none was forthcoming and gradually mathematicians began to believe that Fermat never had a valid proof.

Last month an Englishman working at Princeton, Dr. Andrew Wiles, provided it. It is enormously long and needs many years of training in a special type of mathematics, but the wonderful thing about it is that he did it (unlike the "proof" of the four-color theorem) without the brute force of a computer.

There is still room for human ingenuity in a world where it is considered knowledge to know which button to press on a computer and where "to create" is used for "to create a file."

As a physicist, Fermat was mainly known for discovery of Fermat's principle, according to which a ray of light will always propagate in such a way as to get from one point to another in the shortest possible time. The laws of reflection and refraction are special cases of this principle.

ERROR-CORRECTING CODES

So what's there left to write about for an editor who has been hanging around hospitals instead of doing his homework?

Codes and languages.

Suppose I am using binary code (all zeros and ones) in groups of three: 001, 010, 011, 011, 100, etc. What message this might code is of no interest here. In a perfect world, the groups would all arrive the way they were sent. In reality, channel noise will distort some of the 1s into 0s and some of the 0s into 1s. To protect myself against this, I will count the number of 1s in a group of *information* digits and add a *check* digit by the following arbitrary rule: if the number of 1s is even, I add another 1 as a check digit, otherwise I add a 0. Thus (the hyphen is not transmitted, just inserted here for clarity) my groups become 001-0, 010-0, 011-1, 100-0, etc.

If now the receiver gets a group 011-0, he does not know what went wrong, but he knows that *something* went wrong, for such a group does not exist. He can request that the group be repeated, all of which can, of course, be easily automated.

The example above is that of an error-*detecting* code. By adding more check digits per information digit, the receiver can be told which of the digits is wrong. This is an error-*correcting* code.

There are thousands of error correcting codes around, not necessarily for binary codes. For example, librarians are fond of reversing the order of digits in a book number, so the Library of

Congress numbers protect the number against that kind of distortion.

All of these methods have certain traits in common:

- The message or number contains the actual *information* digits to be transmitted;
- a rather arbitrary and artificial criterion is set up (such as whether the number of 1s is even);
- depending on the fulfillment or non-fulfillment of the criterion, *check digits are added to the information digits to protect them from distortion.*

THE SCHOOL, A SCHOOL, SCHOOL

In 1971 or so I made the not unimportant discovery that natural languages are structured like error correcting codes.

I was well prepared for the subject. I had learned English in England during WWII by listening to it just like you did in America. Then I worked my way through college by teaching English in a language school. The students (Czechs) would say "I have been in Prague yesterday" and "I go to the school to learn English." When I corrected them, they would ask "why?" and I would have no better answer than "Well that's the way you say it." But after class I would sneak to the grammar book and look up the reason. Czech has no articles (nor does any other Slavic language except Bulgarian), and to explain the difference between *a school* and *the school* is easy. But how about plain *school*? Yes, there is a rule, and nobody who has learned the language just by picking it up knows it: the article is omitted when you refer to something associated with the word rather than the word itself. That's why we go to school to learn, to church to pray, to bed to sleep, but the bus stops by *a* church and the lamp stands by *the* bed. Beginning to sound like an artificial criterion that is implemented to protect the message?

If not, let me give you more. Czechs think it strange to make a difference between "I smoke" and "I am smoking." Americans think it strange that when you do something in the Slavic languages, it is required to state whether the action was completed or not.

A statement consisting only of information *morphemes* is made by a child who does not yet speak the language: "Annie want milk." The *s* of *wants* is a check morpheme which is redundant as shown by the "defective" verbs *can, must, may, ought, might* which don't take an *s* in the third person.

The simple English sentence "The teacher stands by the blackboard" requires the gender of the teacher to be made known in French, German, Czech, Russian, and all Slavic languages. This is not because the scene is one of steamy sex, but another arbitrary criterion that these languages require to be answered – a check structure to protect the information. To the contrary, Hungarian has only a single word for *he, she, it*, showing how redundant gender is. (When you hear a foreigner say "Susan? He just went home," you can bet it is a Hungarian speaking.)

To test my claim, I wrote a computer program containing fewer than 100 unprocessed (and exchangeable) English words, from which it could make 10^{28} grammatically correct, though of course not always meaningful, English sentences. By biasing the path at randomly thrown switches and loading the dictionary one could get sentences of various complexity and make the program talk, for example, like a learned lawyer. I also won $1 from a local radio station whose announcer said he could read any tongue twister without going wrong. I sent him two pages of computer-generated tongue-twisters.

WHOSE SHOULDERS DID SHE SHRUG?

But a computer is only a tool, in this case proving that the idea was correct. (It was also used by a linguist from Ohio to write the grammars of some Micronesian languages.)

Then come the real insights that you do not find in the grammar books. For example, English grammar says that all parts of the body must be attributed to their owners whenever possible. A real stupid rule, students of English think. It leads to absurdities like "She shrugged her shoulders." In all other languages I know of you say "She shrugged the shoulders," because to all but mad dogs and Englishmen it is pretty clear whose shoulders she probably shrugged.

But look at language as an error correcting code, and the rule is not stupid at all. The possessive adjective is, in fact, a very good and necessary check morpheme in English and in English only.

In no language that I know of other than English can you simply take any noun and turn it into a verb without changing it. (Exceptions: gold, to guild, and some others.)

This is especially true of parts of the body. You nose around, mouth an opinion, foot a bill, head a committee, shoulder a burden, hand me a note, eye a girl, etc., etc. In any other language that I know of *eye, to eye* and the adjective (as in *eye glasses*) all have distinct forms.

What the "her" does is not indicate *whose* shoulders she shrugged; it is a check morpheme that says "what follows is a noun."

Here is another insight. It is well known that church, schools, literature and general "culture" will standardize and therefore brake the development of a language. To the contrary, the illiterate people, when unhampered by such institutions did a marvelous job of streamlining the grammar and general structure of their language.

When Cicero's eloquence stopped begetting elegant Latin structures and the lights went out in Rome, the common people in Portugal, Spain, France and Italy threw out the Latin inflections bag and baggage, though they were most excellent check morphemes. They must have overdone it for soon they would not have known what is a noun without some help from a check morpheme of a different kind. That's how the article arose in these languages, all descended from Latin, which had none. Instead of the Latin *virgo, virginis, virgini, virginem*, etc., the French just used the far simpler mob-language *la vierge, de la vierge, à la vierge, la vierge, ...*

Same thing happened in the Slavic languages, which inflect heavily to this day. (Czech pays the price of having an old literature by having one more case than Russian.) All except Bulgarian. The Bulgarians came under Turkish rule for 300 years and emerged with a simple language without inflections and with articles.

The third case, of course, is English. For one and a half centuries after the Norman Conquest in 1066 the "better" people spoke French, while the illiterate Anglo-Saxon serfs threw out the inflections (except the "Saxon genitive"), and they made the most beautiful job of streamlining the grammar of a language. When Chaucer and other writers began to stir, they emerged with a bastard French-Saxon language that had the simplest grammar (and the most horrible spelling) in the world.

These and many other points were made in my book *The Structure of Language* (1973), now out of print.

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GALILEAN ELECTRODYNAMICS

Experience, Reason, and Simplicity Above Authority

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6 September, 1993

Dear Subscriber:

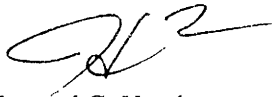
It is my sad duty to convey the news that Professor Petr Beckmann died on the morning of August 3, 1993. In the Nov/Dec issue of *Galilean Electrodynamics* I will present a personal tribute to this giant of a man.

Much to my relief, the present Sept/Oct issue was well in hand when I arrived in Boulder in the middle of August to begin moving the journal to Storrs. I only needed to affix some figures and tables, and to send it immediately to a printer in Connecticut. If things go as planned, the journals will arrive on Tuesday, ready to be put into already prepared envelopes, and sent forthwith. I apologize for the delay.

It is my full intention to continue publishing the journal with much the same philosophy that guided Professor Beckmann.

I look forward to some excellent contributions from our readers.

Best regards,



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Vol. 4, no. 5 September/October 1993

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GALILEAN ELECTRODYNAMICS

Experience, Reason and Simplicity Above Authority

Sept./Oct. 1993 (Vol. 4, no. 5) **Box 251, Boulder,Colorado 80306**

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EDITORIAL POLICY

Galilean Electrodynamics aims to publish high-quality scientific papers based on experimental evidence even if their interpretation of it runs counter to the conventional orthodoxy. In particular, it publishes papers supporting the position that Einstein's interpretation of the Relativity Principle is unnecessarily complicated, has been confirmed only in a narrow sector of physics, leads to logical contradictions, and is unable to derive results that must be postulated, though they are derivable by classical methods.

Though the main purpose of the journal will be publication of logically correct and experimentally supported theories contradicting the Einstein theory, it will, should the occasion arise, publish related, or even unrelated physical topics that rest on logically and experimentally firm ground in challenging other theories cherished by physics orthodoxy.

Where there is more than one theory contradicting accepted opinion and interpretation, but all of them meet the criteria of faultless logic, greater simplicity, and absence of experimental contradiction, none of them shall be favored, except when Occam's razor yields an overwhelming verdict.

All papers are reviewed by qualified physicists, astronomers, mathematicians or engineers. Rejection on the *sole* grounds that a submitted paper contradicts accepted opinion and interpretation will be ignored. The papers in *Galilean Electrodynamics* are generally limited to challenging established orthodoxy *or defending it* against such direct or indirect challenges.

No paper contradicting experiment will be accepted; however, papers making a case why the current interpretation of observed effects may be erroneous will be considered for publication.

All papers are expected to be in the realm of physics, mathematics, astronomy or engineering; non-mathematical, philosophical considerations will generally not be accepted unless they are fairly short and have something new and outstanding to say. Papers reporting experimental results will be given preference over theoretical papers of equally high standard.

Shorter papers will be preferred over long papers of comparable quality; and papers easily grasped at the level of keen seniors and graduate students will be given emphatic preference over esoteric analyses accessible only to a limited number of specialists.

However, none of these restrictions (other than length and subject area) apply to book reviews, news items, and readers' letters; these aresolicited and encouraged to be vividly interesting.

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From the publisher

Experimental refutation of the STR

This is an historic issue: it contains Prof. Hayden's simple and unassailable experimental refutation of the STR.

Einstein, in Sec. 7 of his historic 1905 paper, and his followers ever since (with unsubstantial vaiations), have explained aberration by assuming a star at rest in one inertial frame and the Earth at rest in another. The line joining Earth and Star makes an angle α with the *relative velocity* v between the two systems. Treating the relativistic Doppler effect and aberration in one swoop, Einstein gets the (almost) usual formula for aberration, which for small angles equals $\varepsilon = \beta \sin\alpha$, where $\beta = v/c$, formally identical with the old classical expression where v meant velocity of the earth with respect to the ether rather than Einstein's relative velocity between Star and Earth.

This small difference could not be directly probed, for there is nothing to compare aberration directly to. So what was done since the 17th and 18th centuries was to compare the passage of a star *with constant velocity* through the local meridian at a 6 months' interval, when the Earth's orbital velocity had changed sign, so that subtraction of the two results for ε would give $2(v_{orb}/c)\sin\alpha$. This was in agreement with experiment.

But what if the velocity of the star changed during half a terrestrial year from v_1 to v_2? This is the case for some double stars, with short periods, i.e., so close together that only modern giant telescopes can resolve them. Then the subtraction yields and additional term $\sin\alpha\ (v_1 - v_2)/c$, a term from 20 to 10,000 times the error of observation. But it is absent from all records. With modern methods of scanning the sky, it would appear even if it were not looked for. In some cases the v1 and v2 is nailed down triply: spectroscopically, optically, and by celestial mechanics. The Lorentz transformation, even if it were self-consistent (which many doubt), predicts a value that is not confirmed experimentally.

The Einsteinians will at first stonewall, then come with all kind of political and philosophical "explanations." Keep them to the point: Did Einstein misapply the Theory of Relativity in Sec. 7 of his 1905 paper? if so, is the relativistic Doppler effect also wrong?

Einstein's Theory of Relativity is dead.

The formidable task of this journal over the next decades will be to bury it.

Petr Beckmann

P.S. I have entered the last stage of cancer, have had some operations, and am very weak, which will slow down the work of this journal considerably.

Stellar Aberration

Howard C. Hayden
Professor of Physics, University of Connecticut
Storrs, CT 06269

Stellar aberration, discovered three centuries ago, was immediately recognized as a phenomenon due to the velocity of the Earth in its orbit around the Sun. Einstein explained aberration by using the Lorentz transformations to convert from stellar coordinates to earth coordinates *unequivocally using the relative velocity of Earth and star*, and his explanation remains essentially the same in most textbooks. We show herein, by analyzing data from binary stars, that aberration is *not* due to relative velocity of Earth with respect to star, but rather Earth's orbital velocity.

Introduction — Aberration Basics

Stellar aberration was discovered by Bradley [1728], who was attempting to measure parallax for stars, but accidentally discovered that the telescope needs to be tipped slightly "forward," i.e., toward the direction the Earth is then progressing around the Sun.*

The tilt angle is $(v_{\rm orb}/c)\sin\theta$ radians for stars located in a direction θ with the orbital velocity $\mathbf{v}_{\rm orb}$. The ratio $(v_{\rm orb}/c)$ is about 10^{-4} radians, but exactly $20''.4955$ [Illingworth 1985], which for our purposes will be taken as $20''.5$. Figure 1 shows a typical textbook drawing of the requisite tilt of the telescope. Implicit in the drawing, typical of all those found in textbooks [Feynman 1963, Kutner 1987, Wallenquist 1966, and Yilmaz 1965] is a "raindrop" model in which the drops passing through the center of the objective can strike the center of the eyepiece of the moving telescope only if the telescope is tilted in the amount $v_{\rm orb}/c$. Such a tilt could be discovered only because the Earth's velocity is continuously changing. The apparent location of a star in the sky thus moves around a small ellipse (a circle for stars on the pole of the ecliptic; a straight line for stars on the ecliptic). In addition, there are minor effects due to the Earth's *rotational* velocity [Illingworth 1985].

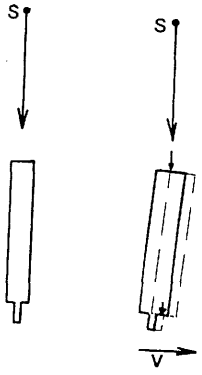

Fig. 1. Typical textbook drawing of the aberration phenomenon. The "raindrop" drawing shows only how a telescope must be tilted, but is not intended as an explanation of the cause.

Stellar Motions

It is necessary to distinguish several real and apparent stellar motions. Aside from line-of-sight velocity that is determined by Doppler shifts, the stellar motions appear as changes in the angle of view. The motion relative to the Sun's system is called "proper motion," and the (changing) apparent position due to Earth's position in orbit is called "parallactic motion." In both cases, the motion is determined by observing the star's varying position relative to those of the majority of the stars on the photographic plates taken weeks or months earlier. If the star moves at some velocity $v_\perp$ with respect to the nearby stars, its angular velocity (proper motion) is $\dot{\phi} = v_\perp/c$, a value that decreases as the distance to the star increases. Proper and parallactic motion have four things in common that are not shared by aberrational motion: both angular motions decrease with increasing stellar distance from the Earth; both motions are of the subject star with respect to the majority of the stars in the same (angular) neighborhood (that is, on the same photographic plate); both motions are due to the changing *relative position of Earth and star;* and both motions are limited to comparatively few stars. Aberration, by contrast, is (A) the same for distant stars (even quasars) as for close ones, (B) angular motion with respect to reference stars far (in the angular sense) from the stars under observation, (C) an effect due to *velocity,* not position, and (D) a motion shared by *all* stars.

Aberration Measurements

The technique used by Bradley [1728] in his discovery of stellar aberration was very clever, and worth reviewing, if only to show why it cannot be universally used. Actually, he was attempting to measure parallax, and he very carefully chose a star for which it was easy to define a reference direction, for he lacked modern clock drives and accurate timing mechanisms that nowadays make the measurement routine. The star γ-Draconis ($RA = 17^h55^m.4$, $dec = 51°30'$) [Burnham 1978] passes very near the zenith direction in Bradley's England, so he fastened his telescope to a chimney and measured the minimum angle $\psi_{\rm min}$ between the zenith and γ-Draconis as the star passed overhead many times over a period of years. The star passed slightly south of the zenith, but not always at the same $\psi_{\rm min}$. In the search for parallax, he had expected the southern-most transit to be in December, but it occurred in March instead. The effect was thus due to velocity, not position, as the two are out of phase. His careful measurements not only led him to the discovery

* Sir Edmund Whittaker, in *History of the Theories of Aether and Electricity*, Thomas Nelson & Sons, London 1910 (revised edition 1951, reprinted 1962), vol. 1, p. 94, footnote 2, points out that "Roemer, in a letter to Huygens of date 13 December 1677, mentions a suspected displacement of the apparent position of a star, due to the motion of the Earth at right angles to the line of sight. cf. *Correspondence de Huygens*, vii, p. 53."

of aberration,[1] but also to the discovery of nutation, because his reference direction was the zenith on the wobbling Earth.

With better apparatus and hindsight Bradley would surely use stellar references instead, if only to avoid the nutation that complicates the measurements. For definiteness, imagine a reference star located along the Earth's velocity vector. All such stars lie on the ecliptic; we may choose γ-Virginis, third brightest star in Virgo as an example, see Fig. 2. This star lies very close to the autumnal equinoctial point, so that we travel directly toward it at the time of the winter solstice, and directly away from it at the time of the summer solstice.

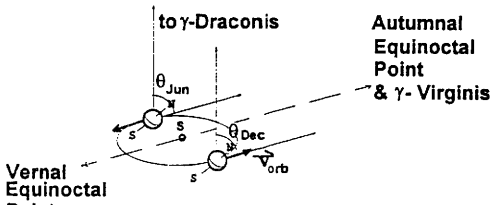

Fig. 2: Operational definition of stellar aberration. The reference direction for aberration measurements is along the present velocity vector $\mathbf{v}_{\rm orb}$. The drawing shows the Earth both at winter solstice and at summer solstice, when the velocity is directed respectively toward and away from the autumnal equinox. For our purposes, the star γ-Virginis (very close to the autumnal equinox) may be chosen as the reference star. The angle θ between the reference star and a star such as γ-Draconis is observed and found to be different in the winter than it was in the summer. The difference is 2×10^{-4} radians, amounting to 41" for a star exactly at the pole of the ecliptic. The semi-major axis of the aberration ellipse is 20".5 for all stars.

Now imagine a star located at the pole of the ecliptic (i.e., in a direction perpendicular to the ecliptic). For a close-enough example, we choose γ-Draconis, which may be seen at either of the two times γ-Virginis may be used as a reference star. The basic fact of aberration is that the sighting angle θ between the two stars is not the same for both observations, but differs by $\theta_{\rm June} - \theta_{\rm Dec}$ radians $= 2 \times 20".5 = 41"$. Such an aberration is called either "stellar aberration" or "Bradley aberration."

Aberration is observed for all stars, including γ-Virginis, which in March and September will be viewed at an angle perpendicular to the velocity. For stars located on the ecliptic, the measurements are complicated by the fact that the angle between the velocity vector and the subject star changes by 360° during the course of a year anyway, and that explains why one must consider the sight angles between two stars, taking into account that both stars may be aberrated, though not by equal amounts.

For our discussion, the salient points are (1) aberration always involves a subject star and the Earth's orbital velocity vector; (2) aberration is always measured as a variation in the sight-angle between the subject star and a reference star as a function of time of year; (3) the major component of aberration is due to the Earth's orbital velocity (with a 1% contribution caused by Earth's rotational velocity); (4) the amount of aberration diminishes from the maximum ($v_{\rm orb}/c = 21".5$, when compared with a hypothetical measurement made at rest with respect to the Sun) toward zero as $\sin\theta$, where θ is the angle between the stars; (5) Bradley aberration is also observed for planets [Mueller 1969].

In actual practice, one uses star catalogues that give right ascension and declination values for stars, as they would be seen from the Sun's frame of reference at a given epoch. Corrections for aberration must then be made by calculating the velocity of the Earth in ecliptic coordinates for the observation time [Montenbruck 1991, Hagen and Boksenberg 1992]. In large telescopes, of course, the aberrational correction is automatically made by computer for the region of the sky being observed, whether observations are being made of stars, planets, the moon, or any other celestial body.

Einstein's Explanation of Aberration

Einstein [1905] was quite specific in his explanation of aberration. In Section 7, "Theory of Doppler's Principle and of Aberration," he uses the Lorentz transformations to convert from a remote source K of electromagnetic waves to the observer's system k: "From the equation for w' it follows that if an observer is moving with velocity v relatively to an infinitely distant source of light of frequency ν in such a way that the connecting line 'source-observer' makes the angle ϕ with the velocity of the observer referred to a system of coordinates which is at rest relatively to the source of light, the frequency ν' ..." Following this, he presents his Doppler formula; then, after a few short lines of uncontroversial algebra, he presents his formula for aberration. We will not review the derivation, because similar calculations can be found in [Born 1962; Fock 1964; Joos 1931; Moller 1952; Misner 1970; Sard 1970] and many others.

For our purposes, the relevant consideration is the assumption underlying all standard SRT derivations, *viz.*, that the result is calculated by applying the Lorentz transformation between the star's and the Earth's frames of reference. For example, Møller [1952] clearly adopts this derivation when he asserts: "...we take S and S to denote the systems of coordinates in which the fixed stars and the Earth, respectively, are at rest." Let us clarify this issue further. In Section 7, Einstein [1905] derives his Doppler formula and his aberration formula, the latter appearing on the same page no more than a few centimeters down the page; *both* formulas contain the velocity, and it is abundantly clear that the same velocity is implied in both. The result in our present notation, where $v_{\rm rel}$ is the relative velocity of Earth and star, is

EINSTEIN'S ABERRATION FORMULA

$$\tan\theta = \tan\theta' \frac{1-(v_{\rm rel}/c)^2}{1-[v_{\rm rel}/c]\sec\theta'}$$

where the angle θ' is the star-Earth angle seen from the star. For velocities much less than the speed of light, this becomes $\theta' - \theta = (v_{\rm rel}/c)\sin\theta$ for the differential (aberrational) angle.

When one considers two positions of the Earth six months apart and applies Einstein's aberration formula to both locations, the result shows only the effect of the reversal of the Earth's velocity. Let us suppose for the sake of argument that a star moves steadily at $v_{\rm star} = 50$ km/s with respect to the Sun. In Einsteinian relativity, there is an aberration due to the 50 km/s, but it is merely an immeasurable offset. That is, at one time of year the relative velocity of the

[1] While the aberrational angle is about 21 seconds of arc, stellar parallax, by comparison, is only a second of arc for the nearest stars, and that explains why Bradley was able to discover aberration over a century before the 1850s when parallax was finally measured [Asimov 1971].

star with respect to Earth is $v_{rel} = 80$ km/s, and six months later, with $\mathbf{v}'_{orb} = -\mathbf{v}_{orb}$ it is $v'_{rel} = 20$ km/s, but when one compares the two readings of the angle θ, the *difference* is still $(v_{rel} - v'_{rel})/c = 2v_{orb}/c = 60(\text{km/s})/c = 41''$.

It is thus clear that SRT regards aberration to be due to the relative velocity of Earth and star. We note in passing that some authors [Shadowitz 1968] have applied the Lorentz transformations rather vaguely, without telling specifically which coordinate systems are being considered. Whether this is implying a new or merely careless approach is not certain. Since such authors do not openly contradict Einstein, we may assume that the intent is to use the obvious coordinate system transformation, *viz.*, that between star and Earth. Leighton [1959] leaves the derivation as a problem for the student.

We will return to this topic in the Conclusions section, but for now, the important conclusion is what may be considered a theorem of SRT:

> The Lorentz transformation equations of SRT assert that there is an aberrational angle $(v_{orb} - v_{star})/c$ radians due to the relative velocity of star and Earth.

Relative Velocity Does Not Cause Aberration

Binary (double) stars are as common as single ones, and are a common interest of amateur astronomers. Burnham [1978] lists five pages of binaries that can be seen in Sagittarius alone with a modest telescope. That is, everywhere one looks in the sky, one may see stars orbiting each other, with all conceivable orbital parameters and all orientations to the line of sight. The binaries present an excellent opportunity for analyzing whether relative velocity of Earth and star is the cause of aberration.

Let us look briefly at the first binary star to be discovered, ζ-Ursae Majoris, known as Mizar, 88 light-years distant [Burnham 1978], the star in the middle of the handle of the Big Dipper. The primary (Mizar A) is an A2 of about 70 times the luminosity of the Sun. It is not a single star, but rather a "spectroscopic binary," a pair of stars whose relative motion is determined by periodic variations in the Doppler shifts; they are so close to one another that they cannot be resolved with any telescope (Fig. 3). Coincidentally, Mizar A was the first spectroscopic binary to be discovered. Each of the stars is about 35 times the luminosity of the Sun.[2] The period of revolution is 20.5386 days, and the separation of the two is about 18 million miles (about 1/5 of the Earth-Sun separation). These numbers imply that the components of this binary orbit their common center of mass at 1.72 times as fast as the Earth orbits the Sun.

As an aside, it is useful to know how the orbital parameters are determined from the periodic nature of the spectra. At a given time, the two components have respectively a blue and a not necessarily equal red shift. The ratio of the shifts gives the ratio of the masses, which is unity in the case of Mizar A. The period is the time for the spectrum of one component to repeat itself, going through both blue and red shifts. From the velocity and the period, one finds the radius of the orbit, or more generally, the shape of the ellipse for elliptical motion, as in the present case, where the eccentricity is 0.54. From celestial mechanics, the period is related to the semi-major axis a by

$$T^2 = \frac{4\pi^2}{G(M_1 + M_2)}$$

and from this, one can determine the masses of the stars, because one also knows the mass ratio M_1/M_2.

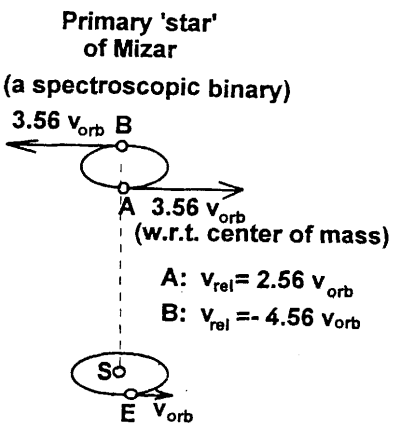

Fig. 3. The relative velocity between Earth and the components of the spectroscopic binary in ζ-Ursae Majoris (Mizar A). Stars A_α and A_β are each about 35 times as luminous as the Sun, are separated by 18 million miles, and move about their common center of mass with a period of 20.5386 days, with a velocity of 1.72 times the Earth's orbital velocity. For the orientation shown, the relative velocities are 0.72 and -2.72 (in orbital velocity units) for A_α and A_β respectively; in 10.3 days, the relative velocities will be reversed (with some very minor correction for the Earth's motion).

Calling one star of this binary A_α, and the other A_β, we may say that at one time, star A_α travels in the same direction as we do at a relative velocity of $0.72v_{orb}$, and A_β travels in the opposite direction at a relative velocity of $-2.72v_{orb}$; 10.3 days later, the velocities are reversed. We may, without loss of generality, assume that the Earth is heading toward γ-Virginis during the 10.3 days while the velocities of A_α and A_β reverse. If indeed, *relative* velocity were to cause aberration, there should be aberrations of $\theta_\alpha = 0.72v_{orb}/c$ and $\theta_\beta = -2.72v_{orb}/c$ at some time t_0. This means that the stars should be separated by $(0.72v_{orb} - [-2.72v_{orb}])/c = 2 \times 1.72v_{orb}/c = 1'10''.5$. In a mere 10.3 days, the velocities will have reversed, and have the values of $\theta_\alpha = -2.72v_{orb}/c$ and $\theta_\beta = 0.72v_{orb}/c$, each star having moved by $1'10''.5$. In fact, this spectroscopic binary is known to be binary only though its red and blue Doppler shifts, because *there is no observable angular separation at all between the two stars of the binary.*[3] As we have seen, stellar movements on the order of 0.01 arc-seconds are routinely measured, so there should be no difficulty in measuring — indeed, viewing with the naked eye — the 10^4 times larger separation due to such aberration, if it occurred.

Mizar is but one dramatic example, and (despite agreement among astronomers) might be faulted on the grounds that we cannot actually *see* its two components individually. Algol, in Perseus, has been recognized since 1782 as

[2] The other "star" of the binary (Mizar B) is also a binary, so that Mizar is correctly called a binary-binary.

[3] An angular separation of $0.007''$ is calculated.

an *eclipsing* binary, although the fact was not confirmed until spectroscopic analysis was performed in 1889. It has an extremely bright component (100 suns); the dimmer one, a little more luminous than the sun, was not observed until 1978. Every 2.78 days the dimmer star passes in front of the brighter, changing the brightness from about 2.1 to 3.4 magnitude, and in between the total luminosity decreases by about 0.1 magnitude when the brighter star eclipses the dimmer. The velocity of the larger component is $1.4v_{\rm orb}$. and that of the dimmer about $7.7v_{\rm orb}$.

For a case where both components can be seen, consider ζ-Sagitarii, which has an angular separation (at maximum) of 0".532, and a period of 21.14 years. In this case the velocities of the components about the center of mass are about $v_{\rm orb}/2$, which, by the relative-velocity argument would result in about 10 seconds of arc differential aberration, some 20 times as great as observed values.

Neither of these binaries, nor any other in the sky exhibits the aberration that would occur if relative velocity determined aberration. [See also Ives 1950, Phipps 1998].

We conclude that

> Experimentally, Bradley aberration is due to the Earth's orbital velocity and *NOT* to *relative* velocity of Earth and star.

Conclusions

The basic facts of stellar aberration are

(A) the apparent direction θ of a star varies around an ellipse varying from a circle (for stars on the pole of the ecliptic) to a straight line (for stars on the ecliptic), the semi-major axis being an angle equal to $v_{\rm orb}/c$ radians, or about 20".5;

(B) The reference direction against which the measurement of aberration is made is the un-aberrated one, namely forward and rearward along the velocity vector of the Earth in orbit, but aberration shows up as a *difference* in sight angles between pairs of stars;

(C) Planets, as well as stars, exhibit aberration;

(D) There is a minor contribution to aberration due to the rotation of the Earth;

(E) Einstein's hypothesis notwithstanding, stellar aberration is most specifically *not* due to relative velocity.

Relativists have argued since Einstein [1905] that the explanation of stellar aberration is a minor triumph of SRT. Specifically, SRT assumes that the Lorentz transformations, based on $v_{\rm rel}$, are correct, and uses them to convert stellar coordinates to Earth ones and conversely. In SRT, then, stellar aberration is nothing more and nothing less than the result of converting the star-Earth angle from one system to the other.

It should be noted that the high stellar velocities with rapidly changing direction required to test — and *reject* — this relative-velocity hypothesis occur only in binary stars where the components are very close together, so close, in fact, that the individual stars cannot be separated with any optical telescope. Though today many thousands of binaries are thoroughly understood through their spectra and well known laws of celestial mechanics, the first discovery of a spectroscopic binary, was that of Mizar A, by Pickering in 1889 [Burnham 1978], only a few short years before Einstein's 1905 SRT paper. Given the somewhat slow communications existing at the time, it is reasonable for Einstein not to have known about the existence of such spectroscopic binaries. One cannot grant this convenient ignorance to the essentially identical explanations found in the more recent literature [Born 1962; Fock 1964; Joos 1931; Møller 1952; Misner 1970].

There will certainly be scientists who wish to salvage SRT by inventing a new explanation. Let us emphasize that the problem lies deeper than mere replacement of the standard SRT derivation with another. The standard derivation proves that there is an aberrational angle $(v_{\rm orb} - v_{\rm star})/c$ radians due to the relative velocity of source and observer, but this conclusion is experimentally false; specifically, the aberrational angle is $v_{\rm orb}/c$, and the stellar velocity is not involved. An alternative derivation, to be acceptable, must not only describe aberration correctly, but simultaneously deny that aberration depends upon the velocity of the star, and thereby deny that the Lorentz transformation between star and Earth is valid.

In other words, to salvage SRT, one will have to contradict Einstein.

Stellar aberration does *not* support SRT; it contradicts SRT.

ACKNOWLEDGMENT

I wish especially to thank Professor Cynthia W. Peterson of the University of Connecticut who has provided much useful criticism of the manuscript. Her help is all the kinder because she does not necessarily share the author's approach to the subject.

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January 6, 1994

Mr. N. Stephan Kinsella
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Dear Mr. Kinsella:

Many thanks for the Shubash Kak article and your "Morality of Capitalism" essay. I am only now able to begin reading it.

The *Phys. Essays* paper (enclosed) was submitted to and rejected by about four physics journals. Arguments for rejection were never direct. Nobody found fault with any discussion of any experiment; in fact, *all reviewers for all journals ignored all experiments.* I would have been happy if somebody paid attention to the question raised, and/or to the experimental discussions, but the fact that everybody did an end-run convinced me that a degree in physics does not necessarily imply that its owner is a scientist. My growing frustration with that process was what drove Petr Beckmann to found the present journal, though by the time things were under weigh, I had the paper accepted in *Phys. Essays.*

Best regards,

Howard C. Hayden
Editor

Is the Velocity of Light Isotropic in the Frame of the Rotating Earth?

Howard C. Hayden

Abstract

Einstein's second postulate refers only indirectly, through the first postulate, to inertial reference frames. Still, few textbooks proclaim that the speed of light is constant in all *reference frames. Since the rotating Earth is not an inertial system, it is reasonable to ask what the speed of light* is *with respect to a laboratory reference frame. The results obtained from several published experiments are fully consistent with vector addition light velocity with velocity due to Earth's rotation.*

Key words: speed of light, relativity, Michelson-Gale, Brillet-Hall, Hafele-Keating

1. INTRODUCTION

Einstein's famous special relativity paper[1] proposed two postulates: (1) the principle of relativity and (2) the independence of the speed of light on the motion of the source. Postulate 2 in that paper is actually rather conservative, referring explicitly to motion of the source (which in the prevalent "ether" theory would not affect light velocity at the receiver anyway) and only indirectly to inertial reference frames.

When one *demands*, as most textbooks do, that an inertial reference frame be used, the reader is led to question what may happen when the reference system is not inertial. Is it implied that in a noninertial system the speed of light is *not* constant?

Many predictions have been derived from these two postulates, and have been successfully confirmed in accelerator physics, atomic physics, and nuclear physics, to name a few branches of physics. Other predictions have met with limited success, especially those of kinematics. For example, no experiment has shown – without initially assuming the constancy of the speed of light or the Lorentz transformation equations – the effect called Lorentz contraction.

Time dilation by the Einstein model is a phenomenon wherein time is slowed in moving systems, and, importantly, *the slowing of time is reciprocal*, that is, both systems see slowed time in the other system. There is overwhelming confirmation that processes are slowed for objects in motion, but this result cannot logically be called "time dilation," because reciprocity has never been observed. We note for the record that any classical model involving "ether" and its cousins also involves slowing of events in systems moving through the "medium," providing that the interaction responsible for the oscillations moves at the speed of light.

The experimental confirmation of Einsteinian *kinematics*, therefore, has met with frustration. Of course, if the speed of light is constant, the kinematical relations must be true, since they follow logically. However, the phenomenal success of Einsteinian *mechanics* (as in accelerators) does not prove that light speed is constant: *the truth of the conclusions does not imply the truth of the premise(s)*. It is the purpose of this paper to review the purely optical speed of light experiments and speed of light comparison experiments to establish just what is known about this important premise.

2. THE FIRST ASYMMETRY: 1913

The Sagnac[2] experiment sent light traveling clockwise and counterclockwise around a rotating table, the result of which was a *nonzero* fringe shift. Since this is the behavior expected in an "ether" theory, wherein the wave would travel at $c \pm r\omega$ around the device, Sagnac[2] concluded that he had proved the existence of the ether. We note that the rotating system of the light source, mirrors, and film had high angular velocity and high centripetal acceleration.

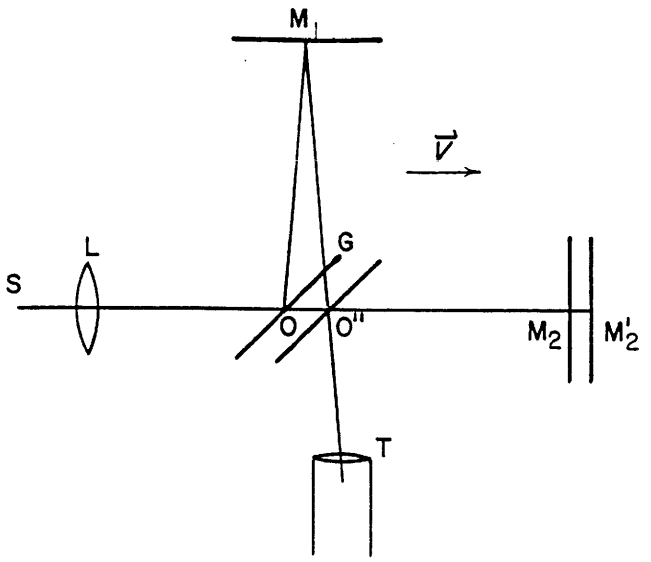

Figure 1. Michelson-Morley apparatus, simplified: The actual apparatus has far more mirrors than are usually shown in texts that describe the Michelson-Morley experiment. The overall path length was about 11 m.

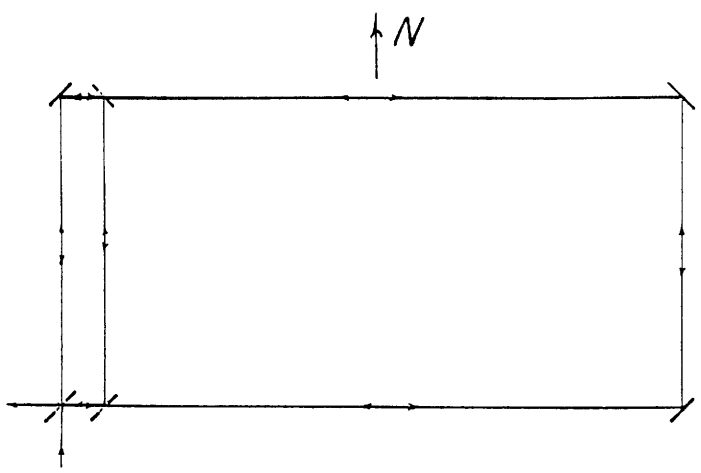

Figure 2. The Michelson-Gale apparatus: The large loop was 1100 ft (335.3 m) by 2000 ft (609.6 m) of 12-in. (30.5 cm) diameter pipe. The smaller was used as a calibration loop. When the central images were aligned, the fringes from the larger loop were more spread out in the amount of 0.23 fringe. Results were consistent with light velocities of $c + v$ and $c - v$ for light traveling east and west respectively, as well as with relativity.

with parallel rays of light traveling in the assumed direction of ether drift of velocity **V**. The round-trip average speed from G to mirror M_2 is as calculated above. Light traveling at right angles to the ether velocity moves at $(c^2 + V^2)^{1/2}$. The difference in average velocities gives rise to a fringe shift[13] for wavelength λ given by

$$\Delta = 2\frac{d}{\lambda}\frac{V^2}{c^2}. \qquad (3)$$

For the conditions in the Michelson and Morely experiment Δ would have been 0.4 for $V = 30$ km/s, the velocity of the Earth in orbit. They detected no Δ values as large as 0.04. Indeed, their rms Δ values corresponded to an ether drift of no more than about 5 km/s.

Joos[14] used a similar apparatus and succeeded in showing an ether drift of less than about 1.5 km/s.

4.2 Michelson-Gale

At some urging Michelson and Gale[15] performed what is certainly the most grandiose, but least-known, optical interference experiment ever performed. Its purpose was to see whether the Earth's rotation would manifest itself in a fringe shift. Figure 2 shows the apparatus: an evacuated pipe forming a rectangle was arranged with mirrors at the corners so that light could travel simultaneously clockwise and counterclockwise around the rectangle. The smaller area was used as a calibration loop.

Michelson's derivation (and, equivalently, Beckmann's) of the predicted fringe shift is based on the assumption that light travels east at $c - r\omega$ and west at $c + r\omega$, where r is the distance $R \cos \phi$ (R = Earth's radius, ϕ = latitude) from the axis of the Earth. The result follows in a few lines of simple algebra and is given below in Eq. (4). See Post[16] for a derivation from relativity theory.

The calculated fringe shift Δ from both the Einstein model and Michelson's is

$$\Delta = (4A\omega \sin \phi)/\lambda c, \qquad (4)$$

where A is the area of the loop, ω is the angular frequency of rotation of the Earth, c is the velocity of light, and λ is the wavelength of the light used. The dimensions of the rectangular light path were 2010 ft (612.6 m) by 1113 ft (339.2 m). One must look back six decades in awe at this experiment in which light traveling over 6000 ft (1828.8 m) in one direction undergoes interference with light traveling over 6000 ft (1828.8 m) the other direction. The experimental result $\Delta = 0.230 \pm 0.005$ agreed well with the predicted result 0.236 ± 0.002. It may come as a surprise to some that a speed of light comparison experiment can ever yield a non-null result; this one does.

Until the advent of satellites the Michelson-Gale experiment had by far the highest sensitivity yet achieved to the rotational velocity of the Earth. The results are fully consistent with special relativity applied in an "inertial" nonrotating frame at the center of the Earth, but they also provide a measurement of the velocity of light with respect to a point on the Earth, albeit somewhat indirectly. [Equation (4) has the area A and the angular velocity ω, but not the velocity directly.]

4.3 Allan *et al.*: Sagnac on a Global Scale

This east-west asymmetry of Eq. (4) was confirmed recently on a planetary scale by the microwave propagation experiment of Allan *et al.*[17] using satellites and several ground stations where Eq. (4) was used to calculate the "Sagnac correction" between remote sites. Only by making such corrections is it possible to synchronize clocks at various positions around the globe. Moreover, the Sagnac correction is not applied just to signals traveling entirely around the globe, but going part-way. Indeed, it was applied in a one-way sense[17]:

> The Sagnac correction from NBS Boulder, CO to Paris, France varies from 71 to 112 ns and from Boulder to Washington, DC, varies from 11 to 13 ns, depending upon satellite position.

4.4 Modern Michelson-Morley Experiments

The advent of masers and lasers has enabled investigators to undertake Michelson-Morley experiments of great precision. In such experiments frequency shifts, rather than fringe shifts, are sought.

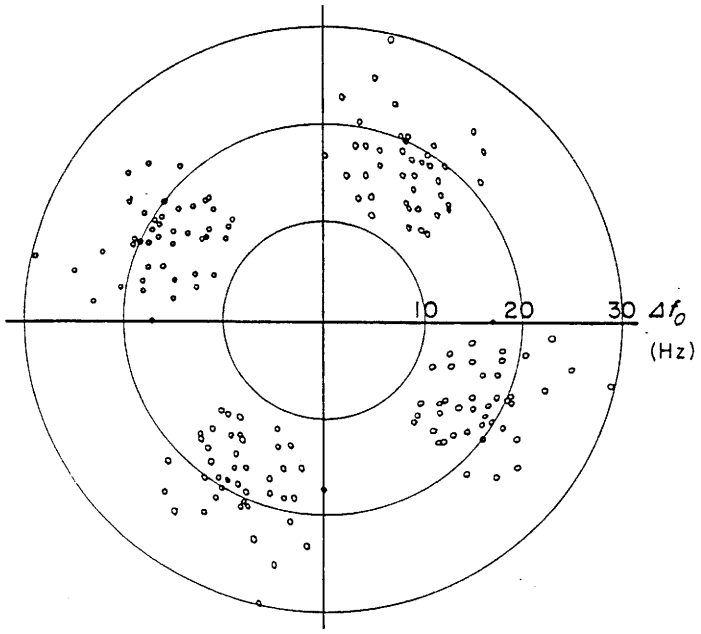

Figure 5. Laboratory data from Fig. 4, translated into all four quadrants: θ_0 values resulting from Fourier analysis may be arbitrarily increased by $n\pi/2$ with no change in the solution. Results shown here demonstrate that the *laboratory-based* data of Brillet and Hall show entirely the incorrect signature for a model in which the speed of light is isotropic in the laboratory frame. (1) No points are at the origin, where the density of points should be the highest. (2) The data are not random in angle; indeed, there are 40° sectors containing no points at all.

The investigators were looking for any effects due to a "cosmic drift" associated with anisotropy is the cosmic blackbody radiation. For this model $V \sim 400$ km/s; a maximum frequency shift amplitude of 79 MHz should result if the direction of the cosmic drift were in the plane of rotation of the apparatus, and zero if the drift were perpendicular to the plane of rotation. If the drift is simply that due to orbital velocity (30 km/s), then the shift amplitude should be 442 kHz at noon and midnight when the orbital velocity vector lies in the plane of rotation of the apparatus, and lowest at 6:00 a.m. and 6:00 p.m. when the velocity is more nearly aligned with the axis or rotation (the trigonometric details are of no interest here).

The offset angle θ_0 should vary with time of day and with time of year, but should always have the same direction with respect to the fixed stars ("cosmic drift model") or with respect to the Earth's orbital velocity ("Sun" model).

For the Beckmann model the shift from Eq. (7) should be given by Δf = (31 Hz) cos 2θ, at all times of the day and year, and θ is the angle of the Fabry-Perot with respect to the east. Special relativity (on the assumption that it is applicable) predicts a shift of zero.

Data were taken in the form of frequency shift versus θ and were Fourier analyzed to determine the amplitude of the various components. A steady drift and cos θ term of 100 Hz amplitude occurred but are of no concern here.

Of interest are the results Δf_0 and θ_0 from Eq. (8), below:

$$\Delta f = \Delta f_0 \cos 2(\theta - \theta_0). \tag{8}$$

The authors report a "persistent spurious" 2θ amplitude of 17 Hz shift (± about 35% for the data set shown) at an "approximately constant phase in the laboratory frame" of about $-30° \pm 10°$. Results for one day's work are shown as open circles in the polar plot of Δf_0 vs θ_0 in Fig. 4, reproduced from the original.

When the (2θ) shifts are translated into sidereal coordinates (+ signs in Fig. 4), they show no systematic dependence and, in fact, are isotropic to within 0.13 ± 0.22 Hz, as shown by the resultant vector. The constancy leads the authors to conclude that to a sensitivity of 3×10^{-9}, the Lorentz transformation is confirmed. Indeed, the results show an absence of effects due to an extraterrestrial "ether" velocity down to a limit of 16 m/s.

The authors have handled their data in a manner such that effects that may arise from the Earth's rotation are ignored. In Beckmann's model the frequency shift from Eq. (7) should be a four-lobed cos $2(\theta - \theta_0)$ curve with 31 Hz amplitude. Noise in the data would result in fluctuations in both magnitude and angle, although the variables are related through Eq. (7) and not simultaneously random. If light velocity were constant in the laboratory, the frequency shift would be zero: noise would scatter data points randomly around the original.

The Fourier analysis performed on the data results in θ_0 values which are in *modulo* $\pi/2$ form, lying in a single quadrant only; any multiple of $\pi/2$ may be added. In other words, any point representing laboratory data may be translated into each of the other quadrants by a 90° rotation. In Fig. 5 we take the liberty of translating the laboratory angle data of Fig. 4 into all four quadrants. The rings represent Δf_0 values of 10, 20, and 30 Hz. The results clearly have the wrong signature for a model wherein light velocity is isotropic in the laboratory frame. First, the data are not centered around $\Delta f_0 = 0$ as they ought to be; indeed, none can be found within the 10 Hz ring where the concentration should be highest. Second, the data are not distributed randomly in angle. Sectors of 40° are entirely devoid of points.

By Beckmann's model the data of Fig. 5 should cluster around angles corresponding to the compass points and should be about 31 Hz in magnitude, diminishing as θ_0 values vary because of noise coupling through Eq. (7). All points are encompassed within a 31 cos $2(\theta - 30°)$ envelope. Even though Brillet and Hall do not provide data on the orientation of their apparatus with respect to the compass points and present data for one day's run only (were data from other days closer to 31 Hz?), it is clear that Beckmann's model enjoys better support than any model that holds that the speed of light is constant in the laboratory frame.

5. CONCLUSIONS AND DISCUSSION

This paper asks the question, What is the velocity of light with respect to a point on the rotating Earth?

The Sagnac[2] experiment showed a pronounced CW/CCW asymmetry in a rapidly rotating system whose magnitude is consistent with velocities of $c \pm r\omega$ with respect to an arbitrary point rotating with that system, although there is evidently a way[16] to explain the results in a manner consistent with the constant velocity notion. The Hafele-Keating[18] experiment proved that the speed of light is not constant with respect to the laboratory frame on the rotating Earth. The phenomenal Michelson-Gale[15] experiment provided a measurement accurate enough to determine the angular velocity of the Earth to ± 2.5%, but could be interpreted as a Sagnac-type experiment. The Allan[17] experiment not only showed the east-west asymmetry in the time of travel for light traveling the globe, but also showed that for signals traveling *part way*, there must be a "Sagnac correction" in order to synchronize clocks. The Brillet-Hall[19] experiment is the clearest in interpretation; its

attempt at a large field in Clearing, Illinois, to measure the effect of the Earth's rotation on the velocity of light." In 55 references E.L. Hill, *Handbook of Physics*, edited by E.U. Condon, does not list the experiment. In a list of some 1600 references C.W. Misner, K.S. Thorne, and J.A. Wheeler, *Gravitation* (W.H. Freeman and Co., 1970) make no mention of Michelson-Gale, even though the experiment is consistent with general relativity theory. E.T. Whittaker, *A History of the Theories of Aether and Electricity: The Modern Theories* (Tomash, Am. Inst. Physics, NY, 1987) is similarly mute. Moreover, the paper is not mentioned in *any* of the papers discussed below which claim to measure the velocity of light, or to compare light speeds in various directions. R.D. Sard, *Relativistic Mechanics* (W.A. Benjamin, NY, 1970) comments that the Michelson-Gale experiment determined the Earth's angular velocity within 2.5%.

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Special Relativity: Problems and Alternatives

Howard C. Hayden

Abstract

Despite a near century of impressive successes and nearly universal acceptance by physicists, Einstein's special relativity theory (SRT) has several problems, most of which arise from a lack of experimental confirmation, but some of which seem to imply a direct contradiction between experiment and prediction. First and foremost, SRT is a theory of relativity, *neatly codified in the Lorentz transformation equations (LTEs), which provide a prescription for converting coordinate values in one inertial system into those of another. That a direct comparison of measurements in two relatively moving reference frames has* never *been done shows that at least half of the theory is unconfirmed. Also, the much-heralded Lorentz contraction has never been demonstrated experimentally. Absence of evidence is not evidence of absence; neither is it evidence of presence. In SRT, when the LTEs are applied to two systems A and B moving at right angles to one another (as seen from a third reference frame O), the velocity of A with respect to B is not the negative of the velocity of B with respect to A. SRT then invokes "Thomas rotation" to explain the asymmetry, although nothing actually rotates. But there is also abundant evidence to show that SRT must, at the very least, engage in tortuous reasoning to explain some experimental results, among them stellar aberration (which in SRT depends upon* relative *velocity of Earth and star); the Sagnac and Michelson–Gale experiments; the Allen around-the-world Sagnac experiment; the Hafele–Keating experiment; the Brillet–Hall experiment; and the Champeney–Moon experiment.*

Key words: relativity, speed of light, time dilation, Lorentz contraction, Champeney–Moon

1. INTRODUCTION

There can be no doubt that Einstein's special relativity theory (SRT) has had a profound effect on physics. It has successfully predicted a broad variety of effects that would surely have astounded Newton.

A huge number of experiments cannot *prove* SRT any more than a huge number of experiments *proved* Newton's mechanics. All rational scientists must agree, then, that there is no basis for believing SRT as if it were the last word in physics. With that as a working hypothesis, I herein present a few holes in the fabric, but only after acknowledging the major experiments supporting SRT.

1.1 Support for SRT

1.1.1 *The Speed of Light is Independent of the Speed of its Source*

The famous light-speed postulate in Einstein's seminal paper[1] is that the speed of light is independent of the velocity of the source. This is well supported by binary stars, some of which *should* show themselves as triplets *if* star speed adds to light speed,[2] Michelson's brilliant but not so famous 1913 experiment with moving mirrors,[3] and the famous experiment of Alvager *et al.*,[4] who measured the speed of light from pions moving at nearly the speed of light, and found c, as expected from Einstein's postulate, rather than nearly $2c$, as would be the case if particle velocity were to add to light velocity.

1.1.2 *"Time Dilation" (Slowdown of Moving Clocks)*

The most famous "time dilation" experiments are those involving moving muons, which have a half-life of 2.2 μs. Formed in the upper atmosphere, they travel at nearly the speed of light, but would decay in intensity to 1/2 in a mere 660 m if it were not for the increase in half-life due to their high speed.[5] Half-lives of high-energy muons in accelerators in one experiment[6] have been measured to be about 39 times the 2.2 μs half-life of the resting muons. A more dramatic experiment, not in the sense of the size of the effect, but in the sense that it involved *real* atomic clocks, was the widely unread Hafele–Keating around-the-world clocks experiment,[7] in which the authors conclude that the results support relativity theory.

The slowdown factor for moving clocks is

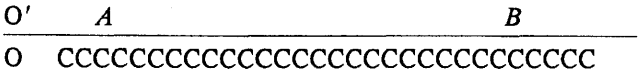
$$\gamma = \frac{1}{(1 - v^2/c^2)^{1/2}}, \qquad (1)$$

where v is the velocity about which more will be said later.

acceleration for muons, how can acceleration be invoked as an explanation for the twin paradox?

1.3.3 *Identical Experiences with Identical Clocks Produce Different Results*

Consider an infinite array of equally spaced clocks C_i along the x-axis of coordinate system O, and two clocks A and B on the x'-axis of O′. All clocks are of identical construction



The following results are directly derivable from SRT and are part of the literature dating back to Einstein's original paper[1]:

(1) If O′ is at rest with respect to O, then all the clocks may be synchronized with one another.
(2) If O′ is moving with respect to O, then in the system O all the clocks C_i may be synchronized with respect to one another, but only *one* of the clocks — A or B, but not both — may be synchronized with respect to the set of clocks C_i. The means of obtaining data in this hypothetical experiment is to have cameras at all clocks C_i simultaneously (in O) take pictures of the system O′. Of the infinite number of pictures, all will be blank, save those showing clocks A and B.

Now consider the means of getting from Case 1 to Case 2 through the simple expedient of accelerating the clocks. Let us make no demands upon the distance of separation, the time of acceleration, or the distance of acceleration. By stipulation, both clocks A and B are initially synchronized with the clocks C_i, begin with the same velocity (zero), and end with the same final velocity **v**.

Einstein's theory is unequivocal about this: as seen from O, clocks A and B have lost their synchronization with respect to C_i, but the loss of synchronization is *different* for A than for B. That is, A may be 4 hours out of synchronization with C_i, while B may be 5 hours out of synchronization with C_i.

Clocks A and B are identical and undergo identical experiences for identical times (as measured in the single reference frame O′, but — according to Einstein's theory — the results are different for A than for B. Einstein's theory thus abandons the notion of causality.

1.3.4 *Lorentz Transformations Along Two Axes*

The vast majority of textbook applications of Einstein's theory cover only the simple cases of motion along a single axis. But there is a problem, apparently known only to a few, that arises when there is motion along two noncollinear axes. Mocanu[10] shows what happens when a coordinate system A moves at velocity $\mathbf{v}_A$ along the x-axis, and another, B, moves at $\mathbf{v}_B$ along the y-axis. When one uses the famous velocity addition theorem to find the velocity $\mathbf{v}_{AB}$ of A with respect to B, and the velocity $\mathbf{v}_{BA}$ of B with respect to A, the peculiar result $\mathbf{v}_{BA} \neq \mathbf{v}_{AB}$ is obtained, although the magnitudes of the relative velocities are equal, $|\mathbf{v}_{BA}| = |\mathbf{v}_{AB}|$. Relativists acknowledge the inequality and apply the Thomas rotation to explain the result. Ungar[11] explains how this is done, and Mocanu[10] shows that the Thomas rotation then leads to further difficulties. Specifically, the scalar product $\mathbf{E}_j \cdot \mathbf{B}_k$ between the electric field vector $\mathbf{E}_j$ in one reference frame with $\mathbf{B}_k$ in another is not an invariant of the electromagnetic field, as it is supposed to be. Apart from that, one is entitled to ask, What rotates? Applying the Thomas rotation to explain the inequality $\mathbf{v}_{BA} \neq \mathbf{v}_{AB}$ is stretching the concept of causality well beyond its normal limits.

1.3.5 *Stellar Aberration*

Einstein[1] was quite specific in his explanation of aberration. In Sec. 7 of Ref. 1, he uses the Lorentz transformations to convert from a remote source K of electromagnetic waves to the observer's system k:

> From the equation for w' it follows that if an observer is moving with velocity v relatively to an infinitely distant source of light of frequency ν in such a way that the connecting line 'source–observer' makes the angle ϕ with the velocity of the observer referred to a system of co-ordinates which is at rest relatively to the source of light, the frequency ν' ... .

Following this, he presents his Doppler formula; then, after a few short lines of uncontroversial algebra, he presents his formula for aberration. We will not review the derivation, because similar calculations can be found in many references.

Numerous references[12–14] point out that stellar aberration is not actually due to the *relative* velocity of the Earth and a star, but rather to the velocity of the Earth in its orbit about the Sun. Defenders of SRT point out that the comparison being made is between the Earth in one reference frame (say, in June) and another (say, in December). That explanation fails another test, however. After all, equations for stellar aberration and the Doppler effect were derived *together*: whatever velocity is used in one necessarily belongs in the other. Phipps[15] has coined the term 'Dopplerstellaraberration" as the 4-vector analog of space-time to indicate the inseparability of the two concepts in SRT. To use *relative* velocity for the Doppler effect, but to use the Earth's *orbital* velocity *in exactly the same 4-vector equation for "Dopplerstellaraberration"* is to deny that causality has any role in the matter.

2. "TIME DILATION" EXPERIMENTS: "CLOCKS" TICK MORE SLOWLY WHEN THEY MOVE — RELATIVE TO WHAT?

Possibly the most frequently cited support for SRT comes from so-called "time dilation" experiments. The question never asked, let alone answered, is whether *time* is dilated, or the moving clocks have slowed down *for cause*, for example, because they traverse the gravitational field of the Earth.[16] Is there an experimental way that one could distinguish between these two seemingly similar notions? Yes there is, and to lay the foundation, we first consider the famous moving-muon experiments.

$$(x' + vt)^2 + y^2 + z^2 = r^2 = c^2t^2. \quad (4)$$

Equation (4) is an anisotropic equation in which the light speed is $c \pm v$ along the $\mp x$-axes, respectively. Phipps[8] points out the distinction between *co*variance expressed in (3) and *in*variance (in this case, of light speed) expressed in (4).

If the physics is correctly described by (4), then the round-trip average speed parallel to the direction of velocity **v** is $\bar{c}_{par} = c(1 - v^2/c^2)$, and the round-trip average speed perpendicular to the velocity is $\bar{c}_\perp = c(1 - v^2/c^2)^{1/2}$. The famous Michelson–Morley[17] (M–M) experiment was intended as a test of (4) by measuring the *difference*

$$\bar{c}_\perp - \bar{c}_{par} \approx \tfrac{1}{2}(v^2/c^2), \quad (5)$$

which is 1.5 m/s for the Earth's orbital velocity (30 km/s $\approx 10^{-4}c$) and is 0.2 mm/s for the Earth's rotational velocity at 40° latitude (350 m/s). Note the dependence in (5) on the *square* of the velocity. The M–M experiment had adequate sensitivity to detect an ether velocity v as small as about 5 km/s, which is much smaller than the Earth's solar-orbital velocity of 30 km/s.

Various other ingenious experiments, usually designed to compare (2a) and (3), have shown unequivocally that light speed is unaffected by the Earth's orbital or galactic velocity. Considering the Earth as a system that is "moving" through the ether at velocity v so that (4) applies, Brillet and Hall[19] found that the v is less than about a meter per second.

It may be important to realize that *all* such experiments have been performed in the *non*inertial frame known as the laboratory gravitationally bound to the rotating Earth. It is a sobering thought that physicists have built up an entire theory about *every* reference frame *everywhere* based on observations made in exactly *one* reference frame.

Perhaps, however, the speed of light is isotropic in the laboratory simply because the dominant gravitational field[16] — or possibly the geomagnetic field[20] — serves to shield the experimental apparatus from the effects of the orbital velocity, much as the shell of a jet plane shields the occupants from the external wind.[20] If this is the case, then a million experiments on the surface of the Earth would not detect an effect that a single free-space experiment might. With this understanding, it is fair to say that (3) has never been tested. Probably, but not necessarily certainly, this invokes ether models. Let us briefly review some history of the matter.

3.1 The Great Luminiferous Ether

3.1.1 *The Nineteenth-Century Ether*

Young's 1811 discovery of the interference of light convinced the world of science that light is a wave phenomenon. It followed that light must be a traveling vibration of *something*, and the nature of that so-called "ether" was a mystery. Light obviously traveled enormous distances through space without distortion to the wave. In the middle of the nineteenth century, when the distance to α-Centauri was measured, and astronomers began to comprehend the vast scope of the heavens, the ether's lack of debilitating properties upon light became even more impressive.

In most of the nineteenth century, the known electromagnetic spectrum was basically limited to the visible light spectrum. Knowledge of wavelengths and the speed of light gradually improved; however, they were known well enough throughout the century to establish that the frequencies were extremely high — several times 10^{14} Hz — with the implication that the ether is of extremely high rigidity and extremely low mass density. Moreover, it was clear that the ether must present vanishingly small resistance to the passage of planets through it.

The motion of the Earth through the ether was viewed more or less like the motion of a baseball through the air. The ether was one thing, the Earth something else, and motion of one through the other was possible. Indeed, Michelson set out to determine that motion with his famous interferometer. In 1883 he obtained a null result in an experiment that was *barely* adequate to detect the orbital motion of the Earth around the Sun. Only in 1887 did he obtain, with the help of Morley, the now-famous null result,[18] to wit: the velocity of the Earth through the ether is undetectable, down to a limit of about 5 km/s, whereas the orbital velocity is 30 km/s.

3.1.2 *Michelson's 1904 Hypothesis*

There were many attempts to explain Michelson's unexpected result, the most famous of which were Lorentz's and Einstein's, but Michelson himself also offered one.[21] Michelson, who clung to a belief in ether until his death, proposed that ether is dragged by the Earth in its motion around the Sun. There were several experimental implications of this idea, the first being the one often described in textbooks, viz., that a M–M experiment on the top of a high mountain might show reduced ether entrainment. But Michelson also proposed that if the ether is entrained also in rotation, then light would take equal times to go eastward as westward around the globe, but if not, then light would take longer to go eastward (into the ether breeze) than westward. Moreover, he noted that it should be possible to do an experiment on a much smaller scale to test the same idea, because it would only be required to measure a fractional wavelength shift.

3.1.3 *The Ether Disappears: Einstein; The Ether Returns: Sagnac*

Einstein's model made the concept of ether superfluous — with the assumption that the speed of light is isotropic in all inertial systems. Then in 1913, Sagnac acted upon Michelson's 1904 suggestion by doing an optical experiment on a table that rotated very rapidly compared to the Earth: several full rotations per minute instead of one per day.[22] He observed a fringe shift that was consistent with the idea of an ether stationary with respect to the laboratory and announced in the title of his paper that he had discovered the ether. This experiment forms the basis for modern optical gyroscopes.

3.1.4 *The Ether Becomes Strange: Michelson–Gale*

In 1924 Michelson, with the help of Gale, measured the rotation rate of the Earth optically, using an optical path of

"consistent with relativity theory."[23]

The Sagnac experiment has been performed on a global scale by Allan *et al.*[28] with the result that it takes about (depending upon satellite positions) 300 ns longer for light to go eastward than westward around the globe over exactly the same path at exactly the same time. Moreover, the asymmetry shows up in the round-trip times between two stations and is not an effect associated only with closed-loop paths.

The existence of this "open-loop" Sagnac effect raises interesting questions about why the Earth's orbital velocity does not lead to similar asymmetries.[29] The Earth moves in a near-circular orbit around the Sun, and mere extrapolation from global scale to orbital scale predicts that the Sagnac effect should exist and that the open-Sagnac effect should also exist. Specifically, it should take longer for light to go forward in the orbit than to go rearward; however, the Michelson–Morley and related experiments decidedly show that such an effect is absent.

3.5 Brillet–Hall

There exists but one experiment that is unencumbered by interpretations that involve rotation and (nearly) sufficiently sensitive to detect any east–west speed differences directly, and that is the incomparable one by Brillet and Hall.[19] Unfortunately, the decimal-chasing experiment is encumbered by its emphasis on investigation of a result already known for nearly a century and on which there is no dispute.

One purpose of the Brillet–Hall experiment was to determine whether our velocity ($\approx$400 km/s in the general direction of the Virgo Cluster of galaxies[30]) with respect to the background blackbody radiation could be detected. By (5), the difference in average perpendicular and longitudinal velocities would be 200 m/s. Neither the Michelson–Morley nor any such experiment since could possibly have missed an effect so large. In other words, we have known for more than a century that any Earth speed in excess of 5 km/s has no effect on the speed of light as measured on the surface of the Earth, and there was hardly any defensible reason for performing the experiment. However (to quote Faraday), "Experiments do not necessarily owe their value to hypotheses accompanying them."[31]

The Brillet–Hall experiment shows asymmetries — consistent with $c\pm v$ velocity addition, where v is the Earth's *rotational* velocity — but the investigators unfortunately focused their attention on the sidereal coordinates, where the results are already known, rather than on laboratory coordinates, where the results would answer important questions. See Ref. 27 for a more complete discussion.

3.6 Mössbauer Experiments

After the discovery of the Mössbauer effect, it became clear that its extreme sensitivity might be used for light-speed anisotropy measurements. Champeney *et al.*[32] performed a Mössbauer experiment as a first-order ether drift experiment and concluded:

> (In fact from a comparison of this dummy run with the actual runs, we may place a limit on V' of eq. (2) of 2.2 $\pm$ 2.2 m/sec.) ... We thus conclude that our measurements, interpreted on the classical assumption of an aether drift, place a limit on any steady drift past the earth, resolved parallel to the equatorial plane, of 1.6 $\pm$ 2.8 m/sec. [Here, V' is the apparent ether-drift velocity due to rotation of the Earth.]

Champeney's experiment was based on a prediction by Ruderfer[33] that ether drift would cause a frequency shift in the Mössbauer experiment that would be first-order in velocity. The Champeney paper cited, but paid no attention to, Ruderfer's subsequent Erratum,[34] which concluded

> The contraction theory [Lorentz–Fitzgerald, in which clocks run slowly by factor of γ] therefore predicts a null effect as does relativity theory for a one-way rotating terrestrial ether drift experiment. The proposed experiment is not a crucial experiment for deciding between the two theories.

Given the Erratum, Champeney was on extremely weak logical grounds to draw his conclusion; in fact, the Erratum presented reasonable grounds for not doing the experiment (just as the Michelson–Morley experiment presented reasonable grounds for not doing the Brillet–Hall experiment). However, Ruderfer's admonition that the experiment would not be crucial was based on 1963 knowledge of clock behavior. More recent experiments with moving clocks enable us to draw definitive conclusions from the Champeney experiment.

3.6.1 *Basic Experiment*

Basically, Ruderfer's experiment involves placing a Mössbauer source at one end of a horizontal tube, with the absorber at the other end. The tube is made to rotate about a vertical axis. Detectors lying just north and just south of the circle of rotation record γ-ray counts. Each detector counts only when the absorber is passing by, so that the south detector counts only when the absorber moves east, and the source moves west. Similarly, the north detector counts only when the source moves east and the absorber moves west.

3.6.2 *Speed-of-Light Effect*

The γ-ray travels from source to absorber at the speed of light in that instantaneous direction. To a close approximation, the time required to traverse the length L of the tube is (in ether theory)

$$t = \frac{L}{c'} \approx \frac{L}{c - V_{\text{drift}}\cos\theta} .$$

Because the tube rotates at angular velocity ω, there is phase-modulation of the received signal, causing a relative frequency shift of

$$\frac{\Delta f}{f_0} = \frac{L\,V_{\text{drift}}\sin\theta}{c^2} , \qquad (6)$$

where f_0 is the frequency of the γ-ray, and L is the distance

periments. The many successes of SRT do lend tremendous credence to the theory, but they do not prove it.

Self-consistency is necessary, of course, but much of it remains illusory. Textbook erudition aside, it is an uncontested fact that Lorentz contraction has *never* been observed in *any* reference frame, let alone in two. A clock moving at speed v ticks slowly by the factor $\gamma = 1/(1 - v^2/c^2)^{1/2}$, but the speed v is the speed of the clock with respect to the gravitational field, *not* the speed with respect to the observer, and the *mutual* slowdown of clocks has *never* been experimentally observed, despite the beautiful textbook arguments proclaiming the self-consistency of the process. In point of fact, *no set of measurements has ever been performed in two mutually moving inertial systems so that they could be compared to see whether the Lorentz transformations are in fact correct.* It is, or should be, sobering to note that the entire edifice of Einsteinian kinematics (including the careful refutations of the violations of "common sense") rests on exactly *one* class of experiments, those showing the slowdown of moving clocks.

The absence of evidence cited in the previous paragraph can also be cited as absence of evidence *against* SRT. Where, one may ask, is any evidence that SRT is incorrect? Critics point to the Sagnac experiment, the Michelson–Gale experiment, the Hafele–Keating experiment, the Allan around-the-world Sagnac experiment, and the *absence* of a forward-rearward light-speed difference when the Earth's motion around the Sun is considered as part of a huge Sagnac experiment, and others.

Defenders of SRT have shown remarkable ingenuity in the face of such assaults. For example, the title of Sagnac's paper indicates his belief that he had found the ether, yet the Sagnac effect is so assimilated into theory today that it is regarded by some[41] as a purely SRT phenomenon. The so-called "twin paradox," regarded by critics of SRT as proving the nonsense of the theory, is given in numerous textbooks expounding SRT as an example of how SRT can easily be misinterpreted by the unwary. The asymmetry of the Hafele–Keating experiment, especially that the westbound clock sped up, is touted as further proof of SRT. The around-the-world Sagnac experiment also shows that the time taken for a light signal to go east always takes longer than to go west over exactly the same path at the same time, *even when the loop is not closed*, yet one will be hard-pressed to find a dedicated SRT defender admit that the speed of light is different in the two directions. "But the laboratory on the Earth is not an inertial frame," reply those who do.[42] But, if the speed of light is not the same in both directions around a rotating system, then the famous Michelson–Morley experiment should have seen a velocity difference forward versus rearward in the orbit, and it did not. *Why did it not?* Because the laboratory on the rotating Earth is subject to many forces (not just gravity); therefore, it is noninertial. The Earth, however, *is*, as a whole, an inertial system, because it is in free-fall.[41]

In my view, there are two experiments that could be done relatively inexpensively that would do much to address the issues raised here.

(1) An around-the-world Sagnac experiment using *only* satellites, with only the result being telemetered to the Earth. We quote from Ref. 43:

> Incidentally, the final suggestion of Michelson,[21] that the orbital motion of the Earth around the sun be detectable in a sufficiently gargantuan ring interferometer, is not consistent with general relativity: a freely falling point object (the whole Earth in this context) defines a local Lorentz frame.

Earth satellites, such as global positioning satellites, thus qualify as inertial systems, one and all. It follows that if several were used as a large Sagnac system, there should *not* be a time difference between signals sent one way and those sent the other way around the globe, according to SRT. However, if light speed is constant with respect to the Earth's field, then there *should* be a time difference.

(2) A shuttle-based Michelson–Morley experiment. The speed of a space shuttle is about 8 km/s, smaller by a factor of 4 than the Earth's orbital speed but larger by a factor of 23 than the surface speed (40° latitude) due to rotation. There is every reason to expect that the Earth's orbital speed should have no effect, but there is at least credible reason to believe that there should be a fringe shift due to the velocity around the Earth.

Therefore, the fringe shift (if it occurs) should be about 500 times as large as it would be on the surface of the Earth, provided that the light speed is constant with respect to the gravitational field.

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Résumé

Malgré près de cent ans d'un succès impressionnant et le fait qu'elle soit acceptée universellement par la plupart des physiciens, la théorie de la relativité restreinte d'Einstein (SRT) n'est pas sans problèmes. Quoique la majorité de ces problèmes semble venir d'un manque de preuves expérimentales, quelques-uns semblent pointer vers une contradiction entre les expériences et les prédictions. Avant tout, la SRT est une théorie de la relativité codifiée par les transformations de Lorentz (LTE) à l'aide desquelles on peut convertir des coordonnées d'un système inertiel à un autre. Le fait qu'on n'ait jamais comparé des mesures prises dans deux cadres de référence en mouvement un par rapport à l'autre montre qu'au moins la moitié de la théorie n'est pas confirmée. De plus, la fameuse