Bad Physics And How Not To Do It

Michael J. Burns

The Cross Product

Consider the cross product as visualized in Figure 1. Two vectors in the X-Y plane are said to have a vector product which points in the Z direction. But what if someone in the universe changes the calibration of the Z axis – from meters to millimeters, say – or of the X axis? What if the Z axis is skewed by someone, authorized or not, in one direction or the other? What if it is bent into a circle?

Figure 1

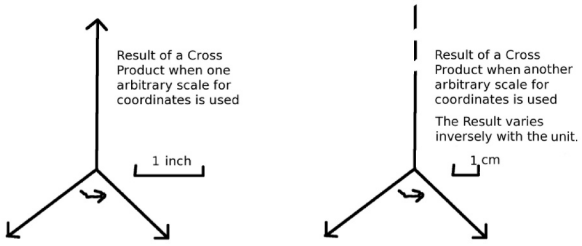
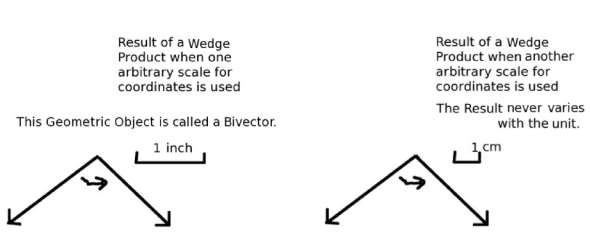


Figure 2



The cross product is presented by physicists in the context of geometric objects. But these tests show that it does not qualify as a geometric object. The result can vary arbitrarily in size and orientation due to artifice. Thus there is a case of bad physics demonstrated here. Else a system of compensating errors is needed to defend the convention.

It's not that weird coordinates should be mastered by beginning students, but that even they ought to know that physics should be done without dependence on even simple coordinates.

The Bivector

The bivector visualized in Figure 2 is a geometric object. It survives unchanged by any coordinate system mischief that an authority can throw at it. It represents a given area in a given plane at a particular location. It has a circular orientation in one direction or the other. And in the context of mechanics it can represent the angular momentum at its location. The geometric units are L^2.

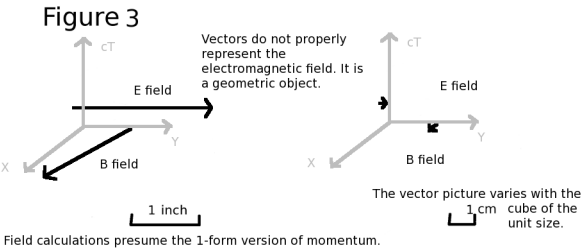
General Covariance

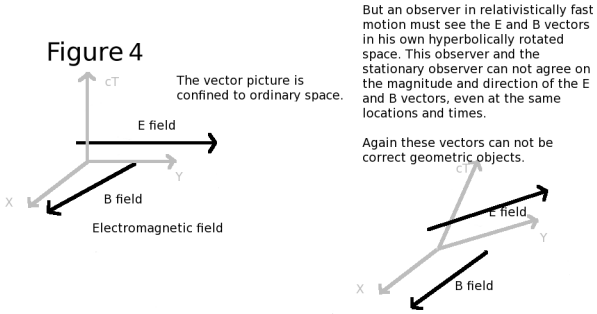
The principles of general covariance and its stronger corollaries are invoked here. Students with gumption will demand the better foundation allowed by these principles. It is only the weakest form of general covariance that demands that physics not be defeated by tricks with coordinates.

When combined with principles borrowed from Spinoza, the strongest corollary is Einstein-Davis and Kaluza-Klein theory – that, until the point of unreason, things should be thought of as made out of unadulterated, albeit curved, spacetime. The sole premise is the existence of the metric – a way to measure the true size of a spacetime interval. It takes a tutorial to appreciate the theorems that follow from these principles.

The Vector Representation Of Electromagnetism

In Figure 3 is a spacetime diagram, with the vertical axis being time. An attempt is made to show the vector versions of the E and B fields here. But they do not survive any kind of coordinate mischief without terminal confusion. And the E and B fields do not survive relativistic transforms without change. The renowned Richard Feynman was confused by this effect. The ephemeral nature of the vector representation led him to assert that any electromagnetic field is also ephemeral, and not the geometric invariant that it actually is, Figure 4.



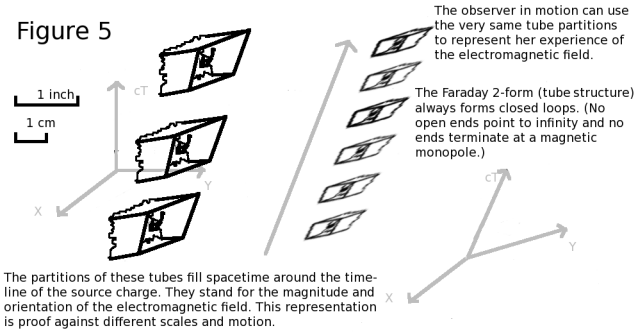


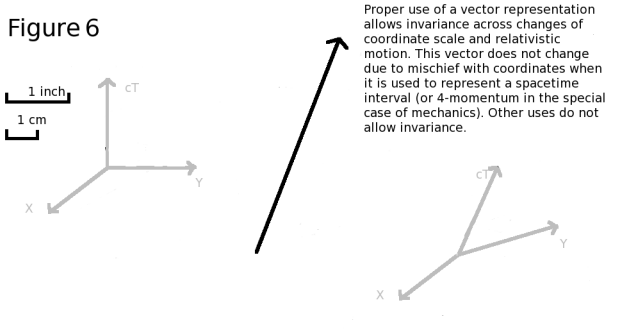
"I don't see little bundles of field lines [when I am] running about because it worries me that if I ran at a different speed the bundles would disappear."

Richard Feynman, Lectures Vol. II, p. 20-10

The Faraday 2-Form Wins.

Figure 5 shows the Faraday 2-form representation of an electromagnetic field (ignoring higher dimensions). It is a geometric object that is stable against all coordinate and relativistic mischief. The form partitions represent the field, not the open directions. The geometric units of a 2-form are L^{-2}. It is directly useful in wave mechanics and field theory. But mechanics requires a conversion back to vector form of the resulting change in momentum for a test charge.





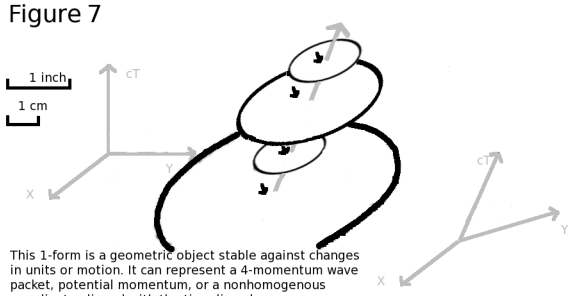
Vectors

How are vectors to be used correctly then? Vectors can represent oriented spacetime intervals as in Figure 6. The context of mechanics allows vectors to represent relativistic momentum. The geometric units are L. Other uses cause problems with general covariance – they are not geometrically stable, not geometric objects.

The 1-Form

The 1-form can represent a coordinate, a wave number, and also momentum in systems other than mechanics. See Figure 7 for the last. Forms tend to represent distributed objects, unlike vectors and bivectors. The geometric units of a 1-form are L^{-1}.

Figure 7

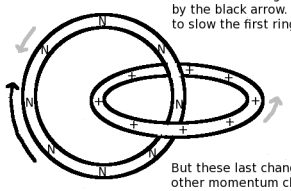


This 1-form is a geometric object stable against changes in units or motion. It can represent a 4-momentum wave packet, potential momentum, or a nonhomogenous coordinate aligned with the time-line shown.

Figure 8

To see a problem with magnetic monopoles: imagine embedding north poles in one solid ring, then embedding positive charges in the other linked ring.

Give the first ring a spin, giving angular momentum symbolized by the black arrow. Then the standard electromagnetic forces act to slow the first ring and accelerate the second, gray arrows.



But these last changes in angular momentum are unbalanced by any other momentum changes that are possible, elsewhere or local, real or potential.

There is a nonlocal and simultaneous transfer of energy from the first ring to the second. But different observers in relativistic motion can not agree on the simultaneity - temporary free energy.

Magnetic Monopoles

The Bianchi identity is a theorem on geometric objects, “The boundary of a boundary is zero.”. Breaking the theorem makes for absurdity such as the behavior of magnetic monopoles. See Figure 8 to understand that conservation of angular momentum is defied in their presence. So magnetic monopoles are not geometric objects despite being posed in that context. One Bianchi identity mandates directly the nonexistence of magnetic monopoles (presuming the conservation of relativistic momentum), and another mandates the conservation of charge. Einstein-Davis and Kaluza-Klein theory constructs a charge as a (somehow quantized) wave in a higher dimension that has a very small extent. But the theory has no way for a magnetic monopole to appear.

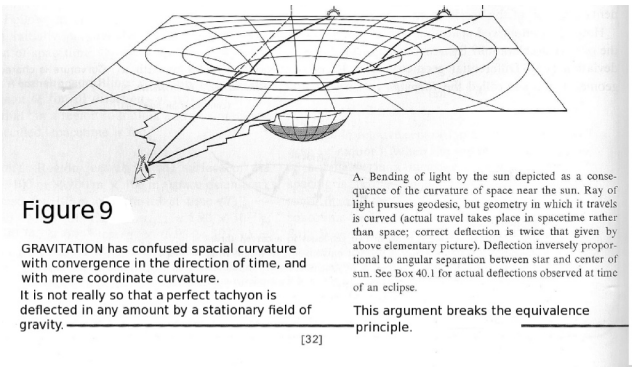


Figure 9

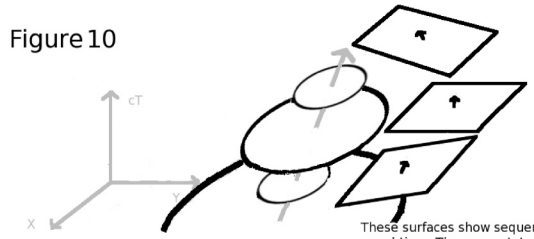
GRAVITATION has confused spacial curvature with convergence in the direction of time, and with mere coordinate curvature.
It is not really so that a perfect tachyon is deflected in any amount by a stationary field of gravity.

A. Bending of light by the sun depicted as a consequence of the curvature of space near the sun. Ray of light pursues geodesic, but geometry in which it travels is curved (actual travel takes place in spacetime rather than space; correct deflection is twice that given by above elementary picture). Deflection inversely proportional to angular separation between star and center of sun. See Box 40.1 for actual deflections observed at time of an eclipse.

This argument breaks the equivalence principle.

[32]

Figure 10



This sequence of partitions, with a natural cosine squared directionality, represent the addition of units of spacetime interval (the loss of units of time) by comparison to flat spacetime.

This diagram allows for the coordinate free understanding of gravity.

These surfaces show sequential spaces of equal time. They are rotated in spacetime by the region of slowed time. The time-line of these spaces is hyperbolically rotated to match and thereby converges toward the center of the region of slowed time as shown by the little arrows. Kindly excuse the exagerated rotation and arc.

Bowling Ball On A Membrane Gravity

Who is there who has attended a physics lecture and not seen the animation of a bowling ball and a smaller ball on an elastic membrane? This is said to be Einstein’s conception of gravity. But the truth is that stationary gravitational fields do not curve space at all. And moving fields create spacial curvature by means of the curvature in the timelike direction rotating into a spacial orientation.

Slow Clocks!

Instead, the curvature is convergent in the direction of time. See Figure 10 to see that centers of redshifted time, or slow clocks, cause the attraction of gravity by way of a hyperbolic rotation of spacetime. Frame dragging and the like are not illustrated here, but are not different in origin.

Bad Physics Denounced

Here is a list of more physical conventions and theories that can each be shown defective by analysis in a similar vein. Students beware.

- The pseudo scalar and other instances of improper tensor rank
- The introductory Lagrangian, mixed tensor rank
- Gauge freedom
- Standard field theory
- The massive vacuum
- String theory
- Exotic matter
- Infinitely hot event horizons
- Inflation and the cosmological constant
- And all other models that are anti-intellectual, ad hoc, hybrid, compound or hypocritically applied

Good Physics

- The Planck and Einstein invariants, and other results from relativity
- Einstein's equations that translate between mechanics and spacetime
- Einstein-Davis and Kaluza-Klein
- Thermodynamics and information theory
- Planck black body radiation
- Parts salvaged from string theory and standard field theory
- The formula for Hawking radiation, at least in the center of the disk of an event horizon so far as I can tell
- Much from loop quantum gravity
- Much from standard quantum mechanics
- Most of quantum logic (Jauch identifies quantum states as a kind of categorical proposition.)
- Nonlocal quantum states, not hidden variables or the many-worlds imterpretation

Bad Philosophy

Many opinions on metaphysics are invalid because each can be shown to entail some sort of bad physics.

- Falsificationism
- Instrumentalism
- Conventionalism
- Theism
- Intelligent Design
- Dualism
- Mysticism
- Relativism
- The Copenhagen School
- Postmodernism

Religion attributes causality to all of metaphysics, outside of the range of the theorems needed to support the application.

Conventions adopted by academic physics do not define the center of the universe. Anti-intellectualism is futile and misleading. Falsificationism is inconsistently applied. It deprecates mathematics without proper cause. And it presumes a cosmic censor capable of disqualifying an otherwise reasonable consequence of mathematics.

Relativism and the like attribute powers of creation to the human brain. But the brain can not reliably and quickly convert contradictions and other sorts of nonmathematics into good and consistent mathematics. Could a grasshopper do this translation so that it might have a chance of survival? Humankind is only capable of partially internalizing the mathematics that is already present.

Spinoza Paraphrased

- Mathematics is out there.
- There is no cosmic enforcer (to put a complex theory in effect where simpler alternatives would otherwise exclude it).
- There is no cosmic censor (to exclude simpler theories from effect wherever they might apply).
- No cosmic censor can endorse coincidences between different mathematical systems by suppressing other possibilities. Coincidences are rare. (Hybrid theories require a conservation theorem and a theorem capable of confining observations to inside the effect of the theory, this in order to begin to compete.)
- There is no dualism or particular boundary between physics and metaphysics.
- Mind your motivation. Fear and greed do not produce good physics.
- Academic motivation and procedure is not required for good physics; neither is religious or political approval.
- But understanding is central to the task. Doing without it only ensures error.
- Illusions of illucidity and arbitrariness attach to the universe when it is not understood.
- The applied purpose of good physics is not just technology, but also its contribution to the understanding of ethics and public policy.

The cumulative application of principles that are almost truisms (as a filter to mathematical possibility) can isolate a particular mathematical system that could hardly be otherwise within the range of the principles applied. This makes for a theoretical method of physics. Albert Einstein was a pretty fair student of Spinoza. But theorists now-a-days are wasting time on the study of systems that depend on unenforceable coincidence.

Kurt Gödel

Professor Gödel proved the existence of logically disparate mathematical systems that can not be reconciled into a single range of expression (short of symbolic emulation). This dramatically changes the Spinozist worldview – entailing a sort of generalized duality between mathematical systems. There is no support for postmodernism here though; mathematics does not fail. Spacetime geometry is not a symbolic system, so Gödel’s proof does not apply.

The need is for principles of expression that can specify which mathematical systems for students to focus on out of those that are logically in range.

Sigmund Freud

Dr. Freud found evidence of the human unconscious. I should not be impelled by circumstance, but I am nevertheless am, to say that it can prevent the understanding of good physics.

Liberal French psychoanalysts write of the cultural neurosis. The first duty of a scientist, I say, is to perceive the cultural neurosis, and then oppose or evade it.

An accident of evolution, I think, is that bad physics is chronically used as a loyalty test by human organizations. The appearance of cross products or magnetic monopoles on an examination is an outrage. Students should raise a ruckus. And the best students might well just accredit themselves.