Re: The speed of gravity revisited

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- *From*: "Tom Van Flandern" <tomvf@xxxxxxxxxxxxxxx>
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[This replies to Mike, Koobee Wublee, and Steve Carlip.]

"Mike" writes:

> [Mike]: There is nothing in Newton's law, F = dp/dt, that says forces propagate at any speed.

To truly understand physics, we must place its laws onto a foundation based on logic. In the discipline known as "deep reality physics", there is only one assumption: "no miracles allowed".

The premises that arise from logic alone rather than from experiments or observations or philosophy or mathematics include these:

** Causality: Every effect has an antecedent, proximate cause.
** Creation: No creation ex nihilo; and no demise ad nihil

For the reasoning behind these and the other principles of physics, see Ref. [1].

As this applies to your statement, when a force is applied to a target body to change its momentum, that new momentum cannot arise from nothing because that is creation ex nihilo. The momentum must be delivered by the force. That means the force itself must have momentum (the product of mass and velocity), which necessitates that the force propagates.

Students often object "What about the force of gravity holding a rock on the ground?" (or some similar example). Even a rock is mostly empty space and can be crushed into a much smaller volume. Gravity forces all its free−to−move entities (such as atomic nuclei or vibrating molecules) to fall. They do so until they collide with a neighbor entity, and they pass along their momentum when they do so. That momentum continues to exist and is passed from entity to entity until it reaches any point of rock−contact with the ground. The ground is held in place by electrostatic forces and sends the received momentum back into the rock, which pushes back on the entities. As long as the force of gravity continues, this cycle of exchanging momentum back and forth continues also, and is responsible for the pressure the rock continually applies to the ground. If there were no gravity to make rock constituents fall, the rock could apply no pressure to another body. Even with gravity, if all rock constituents could be held immobile (say, suspended from above by tiny "strings"), the rock could apply no pressure. It is the (usually unobserved) motion of free rock constituents within the rock that creates any pressure the rock applies and we measure as "weight".

The downward pressure caused by gravity exists in every atom of the rock on the ground, and it flattens or

reshapes the rock to the extent that it can. Only the back−force from the ground prevents the whole rock from moving downward. So the net force on the rock and its net momentum are both zero. But individual atoms or molecules are continually moving or vibrating to the extent they can within the rock in response to these active forces and the momentum they carry.

> [Mike]: You keep talking about "speed of gravity" but you never justified why gravity must have a speed in the first place.

Gravitation originates in a source mass and affects a target body at some distance. Because action at a distance without intermediaries is a logical impossibility, the force of gravity must propagate from the source mass to the target body and transfer momentum to the latter by contact.

> [Mike]: action_at_a_distance is sufficient for NM for all practical purposes

Yes, but that is a form of miracle because it violates the "proximate" part of the causality principle. As Newton himself said: "That one body may act upon another at a distance through a vacuum, without the mediation of anything else, by and through which their action and force may be conveyed from one to the other, is to me so great an absurdity, that I believe no man who has in philosophical matters a competent faculty of thinking, can ever fall into it."

In other words, it requires a miracle. What is your justification for allowing action at a distance as an explanation for any real, physical process? Do you propose to allow miracles, or can you describe a way (that no one else can) for one body to act on another without something passing between them? Think about it.

> [Mike]: In GR, there is only motion, induced by curvature of spacetime due to the presence of mass−energy distribution, and vice versa. It is just a clever model. No connection to reality necessarily.

This mixes concepts badly. "Motion" in spacetime is nothing like motion in 3−space. So you are using the terms "motion" and/or "spacetime" and or "mass−energy" inappropriately. Indeed, no connection to reality is possible without defining terms in a clear, unambiguous way. That is why I specify "3−space" or "4−space" when I use such terms.

One of the objections to the geometric interpretation of GR is that spacetime curvature alone cannot initiate 3−space motion. Only a 3−space force can do that.

> [Mike]: We do not even know what gravity is.

Many of us have had the pleasure of discovering what gravity is physically during the past decade. See 20−author Ref. [2] for the latest research results. In a nutshell, the apple falls from the tree because there is a net graviton wind blowing down toward Earth because Earth blocks part of the graviton wind coming up from below. The fact that this elegant, intuitive picture also gives all the GR effects too is simply a delight.

Perhaps you can express why this fundamental understanding of gravity offends your sensibilities so much, especially now that all classical objections have been answered in a satisfactory way.

and "Koobee Wublee" writes:

> [TomVF]: in LR, the transformations operate in only one direction, from the local gravitational potential field to the moving frame. They do not work in reverse.

> [Wublee]: It is very clear from the following that LR manifests time dilation. ** dt' = dt / sqrt(1 − v^2 / c^2) I don't know how you can argue otherwise.

You have taken the meaning of "t" too literally. "t" is really "time" itself in special relativity (SR) because it applies universally. But because there is no reciprocity to the transformations in Lorentzian relativity (LR), "t" in LR means only the reading on clocks in a single frame. Those clocks are slowed by any motion that the frame might have relative to the local gravitational potential field. And this clock−slowing effect is just like the slowing a pendulum clock experiences when the temperature increases: the clock slows, but nothing happens to real time as used to measure change in the universe at large. So in LR, there is no time dilation, only clock−slowing. The clocks in the local gravitational potential field are "standards", and clocks with a relative motion run slow relative to the standards.

For example, in the Global Positioning System (GPS), which uses LR clock synchronization, all clocks in all orbits are rate−corrected once after launch to agree with a ground master clock. Ever thereafter, all clocks on the ground and in orbit run at the same average rate. GPS then continues to operate without time dilation.

> [Wublee]: In your LR equations, there is no mention of gravitational potential. Thus, what you believe in does not really apply to the equations of LR which you have published.

SR and LR are about the relativity of motion −− only. GR is about the effect of gravitational potential on clocks. All my papers recognize this difference, and most of them mention both effects on clock rates. The same one−time corrections apply both to clock−slowing from motion and clock−speed−up from orbiting in a weaker gravitational potential. See for example Ref. [3].

> [Wublee]: Because of the twin's paradox, SR does not agree with anything. It is utterly absurd of a conjecture.

Then you are in the majority of people who have been taught SR but never really understood it. I agree SR is wrong, but only because it was recently falsified by experiment. I sharply disagree that it is absurd. It is an internally consistent model of nature that might have been right. Read my article in Ref. [4], which is designed specifically to explain SR to people who do not understand how it can make sense. It uses a GPS−type rate−corrected clock on board the spacecraft along with a "normal" clock so the traveling twin always knows what time it is back on Earth "right now", to help show how the twin's paradox plays out.

> [Wublee]: LR does not even degenerate to the Galilean transform at low speeds.

It doesn't need to. Think of LR as simply a way of describing what happens to the rate of atomic clocks when immersed in a gravitational potential field, or when moving through one. It doesn't have anything to say about "time" per se.

> [Wublee]: Yes, the Aether model of GR does seem to explain a great deal. However, in this model, you will find the deflected angle of a photon follows Snell's law. Thus, it is only the Newtonian result not what you are expecting of GR result of twice the Newtonian.

Take a look at Eddington's derivation, Ref. [5]. The refraction−in−an−optical−medium model gives double the Newtonian deflection, just as observed.

> [Wublee]: What you have described does not work for the curvature in spacetime. This is why it was quickly abandoned by the founding fathers of GR which does not include Einstein. Einstein was a nobody. He was a nitwit, a plagiarist, and a liar.

Your hostility is misplaced. Einstein eventually accepted aether, accepted that it was represented by the gravitational potential field, decried the geometric interpretation of GR, and wrote a paper showing why "black holes" are impossible. Most of the stuff you hate, attributed to Einstein, is actually due to his followers, especially since 1970, who have run amok with the theory but continue to get published and get funding by claiming they are just testing and verifying "Einstein's theory".

The continual usage of "spacetime" with a double meaning, and switching meanings as needed to settle any argument with students, is what you should target. There is only one legitimate physical meaning of "spacetime" in GR, and it has nothing to do with space. In brief, it means proper time multiplied by c to express it in space−like units. See Ref. [6].

The math of GR works very nicely. The physical meaning of that math has become so muddled by post−Einstein relativists that we'll have to bring Einstein back from the dead to get it straightened out.

and Steve Carlip writes:

> [Carlip]: Let R contain a single mass M moving at a constant velocity. ... Then both GR and Newtonian gravity agree that a test mass at p will experience an acceleration toward the "instantaneous" position of M. In particular, the direction of that acceleration will track the motion of M.

Correct. The same would be true if M moved with arbitrary acceleration. There was no need for the "constant velocity" assumption except to keep the example simple. As for p, I'm assuming you mean it to be at rest in the selected coordinate system, because moving with M would defeat the purpose of the example.

> [Carlip]: Now, at time t=0, make the following change in R: stop the motion of M. You apparently agree that this change will have no affect at p until the time for a light signal to reach p from R.

Nonsense. What I agreed to was that the gravitational potential field at p would not change until one light−time later than t = 0. However, it is clear from logic, observation, and computer experiments that the force operating at point p changes almost instantly, and any body at point p would cease to accelerate toward mass M almost instantly. Your message fails totally to recognize that field and force are independent physical concepts. These two concepts have a mathematical connection, but one that is ambiguous on the critical point of this discussion: instantaneous or retarded gradient.

A scenario very similar to yours and attempting to illustrate the same points is illustrated in a caption and short animation at Ref. [7]. This animation shows how force changes almost instantly, whereas field effects such as light−bending experience light−speed propagation delay.

> If you really "agree completely with Low's mathematical reasoning," then

you accept this direct consequence of that reasoning.

No, Low made the same oversight you just did. Field and force are two different things. One is retarded and the other is nearly instantaneous. But the physics is very comfortable with that as long as force shapes field and not vice versa.

> [Carlip]: Write down the exact solution of the Einstein field equations for a mass M that initially moves at a constant velocity and then abruptly stops. ... Now just compute the acceleration at p.

Same issue. More on this below.

> [Carlip]: This is not a question of an "interpretation" −− it is a direct, unambiguous mathematical prediction.

You can only say that because you have apparently not understood the real issue. (More below.)

> [TomVF]: The one and only mathematical question of importance here to the speed of gravity issue is this: For a target body with a transverse motion relative to the source mass, should we use the retarded gradient or the instantaneous gradient to get the force?

> [Carlip]: There is no such thing as a "retarded gradient." The gradient of a function is the vector of its spatial derivatives. Time doesn't come into it.

Here you make an elementary mistake. It takes two points (or one point and a direction) to determine a vector. So there is most definitely a "time" issue because there is no remote simultaneity in relativity. That means if the two points are synchronized in M's frame, they are not synchronized in p's frame; and vice versa. So the "gradient" cannot be the same for both frames if they have a relative transverse motion.

Please reflect on this point because it appears to be the key to understanding why the speed of gravity issue cannot be reduced to semantics or swept under the rug in the way that you suggest.

> [Carlip]: It is also an elementary mathematical fact, of course, that if a function at x at time t is determined by the behavior of some source at an earlier time t', then the gradient of the function of x at time t is also determined by the behavior of some source at time t'.

In accord with the relativity principle, you are not entitled to adopt the source mass frame as special and ignore the view from the target body frame, or vice versa. Because of their relative transverse motion, each frame gets a different direction for the gradient function.

> [TomVF]: If this force, or "gravitational influences" (your term), propagates from source mass to target body at speed c, then we must use the retarded gradient, which leads to wrong answers (outward spiraling orbits).

> [Carlip]: You can, in fact, do all of the calculations without ever using

a potential.

Of course. Potentials are simply a mathematical convenience. The core point is that gravitational force shapes the gravitational potential field (the subject of the field equations), and not vice versa. The latter has light−speed propagation delay, the former does not.

Once that distinction is made, the existing equations work. But if you force a light−speed propagation delay onto the force, the equations go badly wrong right away. (Orbits spiral.)

However, I'm telling you little if anything you don't already know. Why the resistance to the obvious? Does tradition outweigh logic? −|Tom|−

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[1] "Physics has its principles", in "Gravitation, Electromagnetism and Cosmology", K. Rudnicki, ed., C. Roy Keys Inc., Montreal, 87−101 (2001); also at http://metaresearch.org/cosmology/PhysicsHasItsPrinciples.asp.

[2] "Pushing Gravity: New Perspectives on Le Sage's Theory of Gravitation", M. Edwards, ed., Apeiron Press, Montreal (2002).

[3] "Gravitational force vs. gravitational potential", http://www.schriever.af.mil/GPS/PAWG/PAWG%201998/Papers/vanflandern.ppt.

[4] "What the GPS tells us about the twin's paradox", in "Einstein, Relativity and Absolute Simultaneity" edited by W.L. Craig and Q. Smith, Routledge, London & New York, pp. 212−228 (2008); also at http://metaresearch.org/cosmology/gravity/gps−twins.asp.

[5] Sir Arthur Eddington, "Space, Time & Gravitation", Cambridge Univ. Press, first published 1920, reprinted 1987, p. 109.

[6] "Does space curve?", http://metaresearch.org/cosmology/gravity/spacetime.asp.

[7] "What if the Sun suddenly disappeared?" Read animation #6 caption at http://metaresearch.org/media%20and%20links/animations/animations.asp, then view animation.

Tom Van Flandern − Sequim, WA − see our web site on frontier astronomy research at http://metaresearch.org

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