Is the Universe Still Flat?
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August 6, 2021

Abstract

Is the universe still flat? Why do so few scientists understand, accept, and discuss the systemic problems inherent in a flat universe metatheory (a.k.a. the Standard Model of Cosmology)?

Furthermore, why are the majority of physicists and astrophysicist so certain, that in the upcoming CERN antimatter gravity free fall experiments, that antihydrogen will fall down in the Earth's gravitational field? And why are the remaining minority so certain that antihydrogen will fall up? Why does no one predict a null result (as I do)?

The upcoming 2022 CERN ALPHA antimatter gravity free fall experiments are crucial tests of quantum gravity. But the predictions, that antihydrogen atoms will fall down or up, are based on false confidence in classical gravity analogies.

Much physics is gravitationally unsolved or disputed. Baryon asymmetry, cosmic inflation, extra dimensions, size and shape of the universe, black hole information paradox, white holes, the equivalence principle, the graviton, quantum gravity, dark matter, and whether gravitational waves carry energy or not are disputed or unsolved gravity physics problems.

If antihydrogen atoms fall down in the Earth's gravitation field, we learn little; if they fall up, we learn a bit more. But with a high precision null result, in CERN's upcoming antimatter gravity free fall experiments, physics and astronomy will need to reconsider everything. I cannot think of another gravity experiment, that is possibly more consequential to the development of quantum gravity and that opens the floodgates of new physics.

So why aren't theorists sharpening their pencils and developing hypotheses that would explain a null result to the upcoming CERN antimatter gravity experiment? Lack of imagination? Overconfidence? Certainty? Let's try to loosen the authority of the peer reviewed crowd.

Galileo said, "In science the authority of thousands of opinions is not worth as much as one tiny spark of reason in an individual man."

If in the CERN antimatter gravity free fall experiments antihydrogen falls up or down; then my recent paper A Toy Gravity Universe and the Quantum Graviton (which predicts a null result) is absolutely incorrect. With a null result, my paper may be mostly correct.

Either way, physics needs a quantum gravity metatheory to guide experimental and mathematical physics. This paper describes how to developing such. The foundation prediction of my quantum gravity metatheory is that antimatter will neither fall up nor down in Earth's gravitational field. Fortunately, CERN has been preparing the necessary experiment for decades.

Background

The successes of 20th century physics weigh upon every physicist and astronomer. A difficulty with first principle research today is that so much physics is well understood. But this is not new; the fundamental challenge of science has always been, how to approach the labyrinth of our ignorance that can't even be framed as an unsolved problem; because we don't even know the questions to ask; and therefore cannot even assert a hypothesis.

I am not a historian of science[1], so pardon my brief summary. 2000 years ago, the idea of matter as in weight and volume was first used by the ancients. 400 years ago, the first stirring of mass as a specific property of all objects was beginning to be understood. 200 years ago, gravitational mass was understood and inertial mass was beginning to be understood. 100 years ago, the relationship between gravitational mass and spacetime was understood; inertial mass clarified with the formulation of the equivalence principle[10]; and the need for merging quantum gravity and general relativity was understood. In the last 50 years, the distinctions between matter and mass and energy have been further drawn into focus[2]. And today, we stand overlooking the past 100 years understanding and verifying so many predictions of quantum mechanics and general relativity to extraordinary detail. And yet, still we are only inching our way toward quantum gravity! Must we endure a thousand years of scattershot research to achieve a quantum gravity?

Many thousands physicist man/woman years have been unsuccessfully spent trying to find the key insight that will drive quantum gravity. We haven't found it. We must be missing something that is either very obvious or profoundly hidden by nature[3,4]. Either way, bigger and more powerful (whether experiment, observation or mathematical formulations) seems unlikely to drive new physics. We need first principles thinking; not flat universe thinking.

The 20th century produced much scientific progress; but also, deep frustrating scientific failures:

- Failure to merge quantum mechanics and gravity
- Failure to identify dark matter
- Failure of supersymmetry to extend the standard model of elementary particles
- Failure to resolve dozens of intractable unsolvable physics problems
- Failure to build a quantum gravity metatheory to guide quantum gravity research

Systemic problems of our current Standard Model of Cosmology

Our current flat universe metatheory (a.k.a. the Standard Model of Cosmology) is accepted for many "reasons" (just as the flat Earth and Ptolemaic Astronomy were "reasonably" accepted).

- The universe "appears" very flat in every direction
- The mathematics of a flat universe is often correct and simpler to use than the mathematics of a sufficiently large appropriately curved model universe.
- We ignore the complex boundary conditions of a flat accelerating expanding universe because that boundary condition is "apparently"[12] far away and without consequence.
- The many successes and apparent[12] successes of the flat universe metatheory presents a large challenge threshold that any replacement metatheory must overcome.

- One's career may be ruined[8] by disagreeing with the dominant flat universe metatheory.
- Systemic problems of the flat universe metatheory are attributed to other areas of physics.

The flat universe metatheory has been useful; but it has created systemic unsolved problems and "apparent" solutions; and needs to be replaced with a curved quantum gravity metatheory.

How to define and build a useful quantum gravity metatheory

The upcoming CERN ALPHA antimatter gravity free fall experiments[5] is crucially important. We do not have a theory of quantum gravity. Therefore, it is uncertain whether antihydrogen atoms will fall down, fall up or neither (null result) in the Earth's gravitational field.

I can think of no other gravity experiment, that is possibly more consequential to the development of new physics, than the upcoming CERN antimatter gravity free fall experiments. Let me assert that a null antimatter gravity result will shine a conceptual first principles light upon many gravitationally misunderstood phenomenon from Standard Model of Elementary Particle (i.e. in a non-supersymmetry way) to the Standard Model of Cosmology. No other upcoming experiment, that I am aware of, has the potential for ushering in so much new experimental and theoretical physics.

First principles work, in my opinion, must be very focused and abide by several guiding constraints; or else it will produce thousands of papers full of wild speculation. The following constraints guide my first paper A Toy Gravity Universe and the Quantum Graviton[6]:

- Focus upon a few key physical insights (i.e. conceptual not mathematical assertions)
- Never disagree with physical evidence (i.e. disagree with interpretation)
- Question even robust theoretical hypotheses if not supported by specific evidence.
- Physical constants of nature remain constant (i.e. not variables)
- Do not change standard equations of physics (i.e. only their domains of relevance)
- Reinterpret/redefine concepts (e.g. the definition of matter, or photons)
- Do not add new equations of physics (i.e. new mathematical equations follow[8,4] the clear conceptual insights of first principle work)
- First principles work must make predictions (i.e. or it is at best speculation)

Essentially, first principles work is free to choose from among the various insights, hypotheses, understandings that are in agreement with all the physical evidence. But first principles work is also free to disagree with all status quo understandings, biases, hypothesis, and predictions that have not been confirmed by experiment. And because of these strong constraints, first principles work of necessity must change the definition of concepts, the domain of relevance of equations, and the interpretation of evidence[9]. For example, the definition of an antiparticle or photon may change as long as it agrees with experiment; the domain of relevance of Newton's gravity equation may change, but not Newton's mathematical equation nor the gravitational constant G.

With these constraints and freedoms in focusing scientific imagination, first principles work attempts to take the best physics insights and physical evidence to build a metatheory that is extremely broad in scope, and that suggests many possible theoretical and experimental branches

of research to explore. These branches should give both explicit and implicit prediction. So for example, if we predict another universe; we must provide an experiment whose predicted result must imply that other universe. Thus the 10^{500} superstring theory alternative universes aren't of concern in this first principles work; because they suggest no predictive evidence in support of any particular multiverse.

Darwin's evolution is perhaps the best example of such a metatheory. Most biologist agree with Theodosius Dobzhansky that, "Nothing in biology makes sense except in the light of evolution."

Toward a quantum gravity metatheory

The first paper of this quantum gravity metatheory, A Toy Gravity Universe and the Quantum Graviton[6], is complete. In it, I modified core concepts, redefined domains of relevance of equations, and reinterpret standard "understanding" of physical evidence. This paper is long; because it takes persistence and logic to physically explain the apparently absurd and apparently unphysical. You will find much to object to on each page; yet I assert it is mostly correct. I ask that you suspend disbelief and follow the logic and physical reasoning. I will be open where and why I disagree with Feynman's and other's standard interpretations. Your assignment is to listen and understand my reasoning to make it even better than I can. Or do you not agree with the failures of 20th century physics; and that our Standard Model is plague with dozens of unsolved problems and questionable workarounds. What is patently absurd is that after 100 years (and 10,000s of scientist's man-years) we have no quantum gravity. A few predictions of A Toy Gravity Universe and the Quantum Graviton include:

- CERN antimatter gravity free fall experiments produce null results.
- Sum of the cosmic redshift energy loss equals the sum of the CMB energy
- There are 4 quantum gravity charge numbers: +i for antimatter, +1 for matter, -1 for CPT antimatter, and -i for CPT antimatter.
- The quantum graviton carries all four quantum gravity charges (+1, +i, -i, -1), has a superposition mass = 0 and a superposition energy = 0.

These predictions build out from the results of a gravity gedanken experiment described in the first paper. This current paper, Is the Universe Still Flat?, is the second paper of a quantum gravity metatheory series. The third upcoming paper, Intrinsic Spin, the Standard Model of Elementary Particles, Feynman Diagrams and Quantum Gravity, will build out these concepts which are briefly touch upon in the first paper.

Since it is not certain whether antihydrogen atoms will fall down, up or give a null result in the Earth's gravitational field; I currently am searching for an alternative gravity gedanken experiment upon which to build a quantum gravity metatheory and a necessary foundation prediction. I have not found another yet. It is quite difficult to find a correct gravity gedanken experiment and prediction[7]. My previous work attests to my failures (too speculative or seriously incorrect in some important detail). I am my harshest critic; though I look forward to your criticism. There is no point to refusing to learn from my misunderstanding. Disclaiming to footnotes and moving goalposts is not my approach to science[8].

Comments and speculations

Intrinsic spin of elementary particles is a little understood area of physics. As I review the literature, I realize that there are few experimentally measured values; many of the accepted intrinsic spin values of particles and antiparticles in the Standard Model are only theoretical. So my working hypothesis (very speculative) is that the correct intrinsic spin values for elementary particles is equal to their current intrinsic spin values (in the Standard Model) times the quantum gravity charge numbers in my first paper. As well, elementary particles' intrinsic spin is relative to time or more correctly, the imaginary number direction i of the CPT subUniverseI. In my mind, this intrinsic spin idea is not a necessary conclusion (just a possible one) from my first paper A Toy Gravity Universe and the Quantum Graviton; hence I only touched lightly upon intrinsic spin in that paper. These intrinsic spin ideas need to be further researched and tested against various evidence before writing my third paper. In particular, testing means trying to break these ideas with physical reasoning and physical evidence.

If these intrinsic spin ideas hold up to my testing; then the Standard Model of elementary particles and the Feynman diagrams system will need to be modified.

Another speculation, regarding the electromagnetic force that is suggested in my first paper A Toy Gravity Universe and the Quantum Graviton. In that paper, the photon is not its own antiparticle. Rather, what I here call a CPT photon is the antiphoton of the photon. But this CPT photon, like the CPT matter and CPT antimatter can not electromagnetically be observed in our visible universe (i.e. subUniverseR). The CPT photon, CPT matter and CPT antimatter can only gravitationally interact with our visible universe. The CPT photon, CPT matter and CPT antimatter can only electromagnetically interact with each other in the CPT subUniverseI. Needless to say, the CPT photon, CPT matter and CPT antimatter of the CPT subUniverseI (I as in imaginary number) can only interact with our subUniverseR (R as in real number) gravitationally. I consider CPT matter or CPT antimatter as a possible explanation of the dark matter observations.

These speculations and others would then be built out more fully in the third paper, Intrinsic Spin, the Standard Model of Elementary Particles, Feynman Diagrams and Quantum Gravity of this quantum gravity metatheory. It is a metatheory; because it is only a guide, that does not include the specifics of mathematical predictions and experimental approaches.

These were too speculative to include in my first paper. I mention then here to give a sense of the direction of a third or later papers. But before I write such papers, I will need the results of the upcoming CERN antimatter gravity free fall experiments (down, up, or null); I will need to seriously try to break these ideas; and I will need to conceptually more fully visualize these ideas to further build out a quantum gravity metatheory with explicit and implicit prediction in our visible universe. Otherwise, it is too speculative to write further about these ideas.

This paper alone is not enough to convince that a quantum gravity metatheory is necessary. Thus, I first wrote A Toy Gravity Universe and the Quantum Graviton[6] as a demonstration of how such a metatheory can be built; and why it is necessary and would be useful in guiding physics and astronomy theoretical, experimental, and observational research.

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