

Gravity has been misunderstood for a century

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Considering the magnificent success of the ‘Standard Model’ in describing the existence and interactions of the incredible zoo of elementary and composite quantum particles that inhabit (or can be forced to materialize in) our universe, it is very difficult to imagine that there is anything in physics that has been misunderstood. Nevertheless, regarding the most fundamental elements of gravitation theory, serious errors have persisted for over a century, impeding progress in the development of every aspect of gravitational theory, including especially quantum gravity.

I believe it fair to say that these errors can be traced to certain unwarranted assumptions made by Einstein in his brilliant but flawed paper of 1911, in which he predicted several phenomena, including, most importantly for our purposes, the red shift of light spectra moving upward in a gravitational field. Einstein correctly attributed this effect to a gravitational reduction of the emission frequencies of atoms at the source. But since no red shift is measured at the source location, Einstein concluded that the instruments used to measure frequencies, namely clocks, must be slowed. The slowing of clock rates led him to jump immediately to the conclusion that the *true* speed of light had to be reduced in order that the *measured* speed of light would be constant, unaffected by gravity, in conformity to his recently proposed (special) relativity theory. Finally, using his assumed gravitational reduction of the speed of light, Einstein predicted the deflection of light rays passing close by the sun.

Over the past century no one seems to have noticed that Einstein had unconsciously assumed that the measurement of distance would be unaffected by gravity: in fact, no one to this very day has even considered this issue. This is no great surprise, but it is really shocking that Einstein’s followers have made no real effort to identify the *cause* of the gravitational red shift. Without a real theory of atomic spectra, it is understandable that Einstein himself did not attempt to determine the cause of the red shift. As we shall see, Niels Bohr’s 1913 quantum theory of the hydrogen atom provided the necessary theory, yet modern day physicists have given only superficial consideration of this issue: they subscribe to the rather mystical idea that *the flow of time itself* is reduced by gravity (“*gravitational time dilation*”), thus ‘explaining’ not only the red shift, but the reduction of the speed of light as well.

One would think that these issues would have long since been seriously reconsidered – but no such study has been undertaken by any member of the physics establishment. One might imagine that a deep knowledge of General Relativity, Quantum Gravity, etc., would be required to succeed in such an endeavor, but in fact, a critique of these unchallenged assumptions is simple and straightforward.

First consider the gravitational red shift of simple atoms, the emission frequencies of which, thank you Niels, are inversely proportional to the Rydberg period, $P_R = h^3 / Z^2 e^4 m_e$. This is true for every type of atom, (Z is the atomic number) regardless of location in a gravitational field. If emission frequencies are reduced by gravity, it has to be true that gravity has somehow caused P_R to be increased. Clearly, the imagined ‘*gravitational time dilation*’ effect cannot be held responsible, since none of the factors in P_R is affected by the ‘*flow of time*.’ One possibility is that the electron rest mass, m_e , has been *decreased*. So it is natural to see whether this may be the case.

Consider the annihilation of positronium (an atom-like structure comprising an electron and its anti-particle, a positron) deep in a gravitational field. In the annihilation process, the entire rest mass of the electron – positron pair is converted into pure electromagnetic radiation: gamma rays. Because of the gravitational red-shift effect (not yet understood, but experimentally verified!) the total energy of these gamma rays will be measured by observers higher up in the gravitational field to be reduced in energy as compared with the same type event occurring locally and observed locally. The unavoidable conclusion is that rest masses are reduced by gravity – contrary to the unwarranted assumption that rest masses are unaffected by gravity.

So finally, the cause of the gravitational red shift may now be understood to be the *gravitational reduction of rest masses*. But what about the speed of light, and the measurement of distance? Niels Bohr in his quantum theory of the hydrogen atom, not only revealed the dependence of the Rydberg on the fundamental ‘constants’ of nature, he also gave us the radius of the hydrogen atom, now called the Bohr radius, $a_0 = h^2/e^2 m_e$. Since rest masses are reduced by gravity, we see immediately that, since all lengths must vary together, measuring rods will be elongated. Thus distance measurements are reduced by the same factor that affects time measurements. Consequently, Einstein’s angst regarding the measured speed of light is assuaged, the *true* speed of light is restored as a constant, and finally the concept of *gravitational time dilation* is vitiated.

The theoretical implications of *gravitational rest mass reduction* are many and profound. First consider the nature of gravitational potential energy. We have seen that rest masses are reduced by gravity: this means that if one *lifts* a massive object, the rest mass of the object will *increase* by exactly the amount $\Delta m = \Delta w/c^2$, where Δw is the work done in lifting the object. Thus, finally, the mysterious nature of gravitational potential energy is revealed: the change in the gravitational potential energy of a massive body exists as a change in the rest mass of the body itself: $\Delta E = \Delta m/c^2$! Clearly, for photons and the quanta of other massless fields, there is no gravitational potential energy.

In contrast, the presently accepted concept of gravitational potential energy holds that the energy resides in the gravitational field itself. Awkwardly, since the absolute value of gravitational field strength increases as gravitating masses are brought together, this model, in order to account for the attractive nature of gravity, would require the gravitational field to have a *negative energy density*! But since, as has been proven, the gravitational potential energy of a body resides in the body itself, it is clear that the energy density of the gravitational field itself should be identically zero. This squares with the well-known fact that any formulation of the energy-momentum *tensor* (not pseudo-tensor!) of a gravitational field obeying Einstein’s theory must be identically zero, since, in any freely-falling reference system, every component of the tensor vanishes: then, by the very nature of tensors, it must vanish in every frame of reference.

As we have discovered, the gravitational red shift occurs at the source because of rest mass reduction: light moves upward with constant energy. Thus, in this instance, gravity itself does not directly affect light. But in another context, namely the ‘bending’ of light rays passing close by the sun, astronomers and physicists claim that this bending proves that light feels the force of gravity. Incredibly, the conflict with the red shift effect, in which light’s energy is unaffected, seems not to have been noticed. At this point the heretofore unknown but crucially important phenomenon, *gravitational size dilation*, enters to reconcile the two situations involving the interaction of light and gravity. As has been noted, the measurement of distance is affected by gravity. It turns out that when the metric is corrected for this

effect, light rays are found to move along the spatial geodesics of the new *correct* metric, proving that the bending is due to the curvature of space, a purely geometrical effect, and that light does not feel the force of gravity.

This fact undermines Einstein's strongly asserted but unproven assumption that every form of energy interacts with gravity – is affected by gravity, and acts as a source of the gravitational field. The negation of this concept is arguably the most important consequence of gravitational rest mass reduction. It suggests that the *effective* source of the gravitational field should be the *trace* of the energy-momentum tensor of the matter present, a scalar which vanishes in the case of free massless fields, such as the free electromagnetic field. This would insure that no free massless field would act as a source of gravity. (It must be noted that *confined* radiation, as for instance in the body of a star, exhibits an equivalent rest mass and does interact with, and contribute to, the gravitational field).

The non-coupling of light to gravity is critically important in attempts to formulate a quantum theory of gravity. The fact that gravitating bodies attract one another requires that the hypothetical graviton have either spin zero or spin two. Spin zero has been rejected because of the 'bending' of light rays, on the grounds that spin zero quanta can only couple to the trace of the energy-momentum tensor of the target field, and in the case of light, that trace is zero. But, as we have just seen, there is no coupling! This means that the hypothetical graviton must be spin zero, since a graviton of spin two *would* couple to the complete energy-momentum tensor the electromagnetic field. Of course, gravity's inverse square law requires the graviton to be massless: thus, according to the theory just developed, gravitons are not affected by gravity, they do not act as sources of gravity, and they do not interact with one another! In this respect, the situation is analogous to the relation of photons to the electromagnetic field and to one another. Within the same analogy, rest mass acts as the 'charge' for the gravitational field. But the analogy breaks down since electric charge is invariant and the electromagnetic field possesses energy, whereas in the case of gravity, potential energy resides not in the field, but rather in the variable rest mass energy of the 'charges.' The non-interactive character of the graviton eliminates dreaded non-linearities, and gives promise of a linear, spin-zero scalar theory – a radical and welcomed simplification of the problem of formulating a quantum theory of gravity.

The variable rest mass concept also enables important and revelatory insights in the theory of Black Holes and Cosmology, as presented in my paper, *Einstein's Theory of Gravity: Misunderstood for a Century*, available on line from Research Gate:

<https://www.google.com/search?q=Einstein%E2%80%99s+Theory+of+Gravity%3A+Misunderstood+for+a+Century>

The reader may also be interested to read my book, *Einstein, the Aether & Variable Rest Mass*, which covers a much broader range of topics. It is available from Amazon, or on line at:

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