

Zero Point Energy - What is it?

Quote - **The spinning whirling energy in the universe, harnessable by mankind. Now.** "We are whirling through endless space, with an inconceivable speed, all around us everything is spinning, everything is moving, everywhere there is energy... There must be some way of availing ourselves of this energy more directly. Then, with the light obtained from the medium, with the power derived from it, with every form of energy obtained without effort, from the store forever inexhaustible, humanity will advance with giant strides. The mere contemplation of these magnificent possibilities expands our minds, strengthens our hopes and fills our hearts with supreme delight." — Nikola Tesla, referring to Zero Point Energy in 1891

science & spirit

exploring things that matter

Brilliant Disguise: Light, Matter and the Zero-Point Field

Is matter an illusion? Is the universe floating on a vast sea of light, whose invisible power provides the resistance that gives to matter its feeling of solidity? Astrophysicist Bernhard Haisch and his colleagues have followed the equations to some compelling -- and provocative -- conclusions.

by *Bernard Haisch*

Is matter an illusion? Is the universe floating on a vast sea of light, whose invisible power provides the resistance that gives to matter its feeling of solidity? Astrophysicist Bernhard Haisch and his colleagues have followed the equations to some compelling — and challenging — conclusions.

"God said, 'Let there be light,' and there was light."

It is certainly a beautiful poetic statement. But does it contain any science? A few years ago I would have dismissed that possibility. As an astrophysicist, I knew all too well the blatant contradictions between the sequence of events in *Genesis* and the physics of the Universe. Even after substituting eons for days, the order of events was obviously wrong. It made no sense to have light come first, and then to claim that the Sun, the moon and the stars — the obvious sources of light in the night sky of the ancient world — were created only subsequently, be it days or eons later. One could, of course, generalize light to mean simply energy, and thus claim a reference to the Big Bang, but that would, to me, be more of a stretch than a revelation.

My first inkling that the deceptively simple "Let there be light" might actually contain a profound cosmological truth came in early July 1992. I was trying to wrap things up in my office in Palo Alto so that I could spend the rest of the summer doing research on the X-ray emission of stars at the Max Planck Institute in Garching, Germany. I came in one morning just before my departure and found a rather peculiar message on my answering machine; it had been left at 3 a.m. by a usually sober-minded colleague, Alfonso Rueda, a professor at California State University in Long Beach. He was so excited by the results of a horrifically-long mathematical analysis he had been grinding through that he just had to tell me about it, knowing full well I was not there to share the thrill.

What he had succeeded in doing was to *derive* the equation: $F=ma$. Details would follow in Germany.

Most people will take this in stride with a "so what?" or "what does that mean?" After all what are F , m and a , and what is so noteworthy about a scientist deriving a simple equation? Isn't this what scientists do for a living? But a physicist will have an incredulous reaction because you are not supposed to be able to *derive* the equation $F=ma$. That equation was postulated by Newton in his *Principia*, the foundation stone of physics, in 1687. A postulate is a law that you *assume* to be true, and from which other things follow: such as much of physics, for example, from that particular postulate. You cannot derive postulates. How do you *prove* that one plus one equals two? The answer is, you don't. You assume that abstract numbers work that way, and then derive other properties of addition from that basic assumption.

But indeed, as I discovered when I began to write up a research paper based on what Rueda soon sent to Garching, he had indeed derived Newton's fundamental "equation of motion." And the concept underlying this analysis was the existence of a background sea of light known as the electromagnetic zero-point field of the quantum vacuum.

To understand this zero-point field (for short), consider an old-fashioned grandfather clock with its pendulum swinging back and forth. If you don't wind the clock, friction will sooner or later bring the pendulum to a halt. Now imagine a pendulum that gets smaller and smaller, so small that it ultimately becomes atomic in size and subject to the laws of quantum physics. There is a rule in quantum physics called the Heisenberg uncertainty principle that states (with certainty, as it happens) that no quantum object, such as a microscopic pendulum, can ever be brought *completely* to rest. Any microscopic object will always possess a residual random jiggle thanks to quantum fluctuations.

Radio, television and cellular phones all operate by transmitting or receiving electromagnetic waves. Visible light is the same thing; it is just a higher frequency form of electromagnetic waves. At even higher frequencies, beyond the visible spectrum, you find ultraviolet light, X-rays and gamma-rays. All are electromagnetic waves which are really just different frequencies of light.

It is standard in quantum theory to apply the Heisenberg uncertainty principle to electromagnetic waves, since electric and magnetic fields flowing through space oscillate like a pendulum. At every possible frequency there will always be a tiny bit of electromagnetic jiggling going on. And if you add up all these ceaseless fluctuations, what you get is a background sea of light whose total energy is enormous: the zero-point field. The "zero-point" refers to the fact that even though this energy is huge, it is the lowest possible energy state. All other energy is over and above the zero-point state. Take any volume of space and take away everything else — in other words, create a vacuum — and what you are left with is the zero-point field. We can *imagine* a true vacuum, devoid of everything, but the *real-world* quantum vacuum is permeated by the zero-point field with its ceaseless electromagnetic waves.

The fact that the zero-point field is the lowest energy state makes it unobservable. We see things by way of contrast. The eye works by letting light fall on the otherwise dark retina. But if the eye

were filled with light, there would be no darkness to afford a contrast. The zero-point field is such a blinding light. Since it is everywhere, inside and outside of us, permeating every atom in our bodies, we are effectively blind to it. It blinds us to its presence. The world of light that we do see is all the rest of the light that is over and above the zero-point field.

We cannot eliminate the zero-point field from our eyes, but it is possible to eliminate a little bit of it from the region between two metal plates. (Technically, this has to do with conditions the electromagnetic waves must satisfy on the plate boundaries.) A Dutch physicist, Hendrik Casimir, predicted in 1948 exactly how much of the zero-point field would end up being excluded in the gap between the plates, and how this would generate a force, since there is then an overpressure on the outside of the plates. Casimir predicted the relation between the gap and the force very precisely. You can, however, only exclude a tiny fraction of the zero-point field from the gap between the plates in this way. Counter-intuitively, the closer the plates come together, the *more* of the zero-point field gets excluded, but there is a limit to this process because plates are made up of atoms and you cannot make the gap between the plates smaller than the atoms that constitute the plates. This Casimir force has now been physically measured, and the results agree very well with his prediction.

The discovery that my colleague first made in 1992 also has to do with a force that the zero-point field generates, which takes us back to $F=ma$, Newton's famous equation of motion. Newton — and all physicists since — have assumed that all matter possesses an innate mass, the m in Newton's equation. The mass of an object is a measure of its inertia, its resistance to acceleration, the a . The equation of motion, known as Newton's second law, states that if you apply a force, F , to an object you will get an acceleration, a — but the more mass, m , the object possesses, the less acceleration you will get for a given force. In other words, the force it takes to accelerate a hockey puck to a high speed will barely budge a car. For any given force, F , if m goes up, a goes down, and vice versa.

Why is this? What gave matter this property of possessing inertial mass? Physicists sometimes talk about a concept known as "Mach's Principle" but all that does is to establish a certain relationship between gravity and inertia. It doesn't really say how all material objects *acquire* mass. In fact, the work that Rueda, I and another colleague, Hal Puthoff, have since done indicate that mass is, in effect, an illusion. Matter resists acceleration not because it possesses some innate thing called mass, but because the zero-point field exerts a force whenever acceleration takes place. To put it in somewhat metaphysical terms, there exists a background sea of quantum light filling the universe, and that light generates a force that opposes acceleration when you push on any material object. That is why matter seems to be the solid, stable stuff that we and our world are made of.

Saying this is one thing. Proving it scientifically is another. It took a year and a half of calculating and writing and thinking, over and over again, to refine both the ideas themselves and the presentation to the point of publication in a professional research journal. On an academic timescale this was actually pretty quick, and we were able to publish in what is widely regarded as the world's leading physics journal, the *Physical Review*, in February 1994. To top it off, *Science* and *Scientific American* ran stories on our new inertia hypothesis. We waited for some reaction. Would other scientists prove us right or prove us wrong? Neither happened.

At that point in my career I was already a fairly well-established scientist, being a principal investigator on NASA research grants, serving as an associate editor of *the Astrophysical Journal*, and having many dozens of publications in the parallel field of astrophysics. In retrospect, my experience should have warned me that we had ventured into dangerous theoretical waters, that we were going to be left on our own to sink or swim. Indeed, I would probably have taken the same wait-and-see attitude myself had I been on the outside looking in.

An alternative to having other scientists replicate your work and prove that you are right is to get the same result yourself using a completely different approach. I wrote a research proposal to NASA and Alfonso buried himself in new calculations. We got funding and we got results. In 1998, we published two new papers that again showed that the inertia of matter could be traced back to the zero-point field. And not only was the approach in those papers completely different than in the 1994 paper, but the mathematics was simpler while the physics was more complete: a most desirable combination. What's more, the original analysis had used Newtonian classical physics; the new analysis used Einsteinian relativistic physics.

As encouraged as I am, it is still too early to say whether history will prove us right or wrong. But if we are right, then "Let there be light" is indeed a very profound statement, as one might expect of its purported author. The solid, stable world of matter appears to be sustained at every instant by an underlying sea of quantum light.

But let's take this even one step further. If it is the underlying realm of light that is the fundamental reality propping up our physical universe, let us ask ourselves how the universe of space and time would appear from the perspective of a beam of light. The laws of relativity are clear on this point. If you could ride a beam of light as an observer, all of space would shrink to a point, and all of time would collapse to an instant. In the reference frame of light, there is no space and time. If we look up at the Andromeda galaxy in the night sky, we see light that from our point of view took 2 million years to traverse that vast distance of space. But to a beam of light radiating from some star in the Andromeda galaxy, the transmission from its point of origin to our eye was instantaneous.

There must be a deeper meaning in these physical facts, a deeper truth about the simultaneous interconnection of all things. It beckons us forward in our search for a better, truer understanding of the nature of the universe, of the origins of space and time — those "illusions" that yet feel so real to us.