

Atomic Clocks and Relativity

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Abstract. There are two physical effects which cause atomic clocks to run slower. These are motion and gravity, and the rate of retardation can be quantified using equations that are closely related to the equations of relativity. This article will examine why this should be, and what the common physical mechanism is between motion and escape velocity that results in these two factors having an identical physical effect on the clock mechanism.

Kinetic Energy

I. Assuming that ponderable matter has an intrinsic energy, mc^2 , where the numerical value of c remains unspecified, then it follows that kinetic energy on the large scale is an additional $\frac{1}{2}mv^2$ on top of this, where v is the translational speed of the body. The total energy E is therefore,

$$E = mc^2(1 + v^2/2c^2) \quad (1)$$

assuming mass to be constant. Kinetic energy is therefore like a kind of longitudinal Doppler shift of the intrinsic energy.

Gravitational Potential Energy

II. In addition to kinetic energy, when a body is in a gravitational field, it will possess gravitational potential energy. Since this article mainly concerns the intrinsic energy within the caesium atoms in an atomic clock, then because gravitational field strength has the same physical effect on the internal mechanism of an atomic clock as kinetic energy does, a redefinition of gravitational potential energy will be made which better emphasizes this reality. The existing definition of gravitational potential energy with its negative sign masks the cyclical oscillation of the internal energy inside a GPS clock in an elliptical orbit. It is therefore proposed that the gravitational potential energy of a body of mass m in the gravitational field of a body of mass M is,

$$\Phi = +2GMm/R = mu^2 \quad (2)$$

where G is the gravitational constant, R is the distance between the centres of M and m , and u is the escape velocity. The gradient will therefore be negative, in line with the fact that gravity acts downwards. The factor of 2 has been introduced in order to cater for the effect that gravity has on the internal structure of ponderable matter, over and above the acceleration that it causes on the large scale. The negative sign in the standard textbook definition of gravitational potential energy introduces instantaneous conservation of energy which has the disadvantage of masking the additive effects that gravitational field strength and kinetic energy have on the internal mechanism of atomic GPS clocks that are undergoing eccentric orbits around the Earth. Choosing a plus sign on the other hand introduces more transparency by highlighting the cyclical nature of energy conservation in GPS clock orbits. The factor of 2 doubles the normal force of gravity in order to account for the existence of a latent component which is absorbed internally by the constituent molecules of the orbiting clocks. The idea is that this latent component, not observed on the large scale, causes a torque to act on the individual constituent atoms and molecules due to their dipolar nature, hence inducing a centrifugal pressure, and so increasing their intrinsic energy while possibly decreasing their angular frequency, just as planets in higher orbit have higher total energy but a lower orbital frequency.

It should also be stated that the definition of gravitational potential energy at equation (2), while favourable in matters relating to the internal energy in GPS clocks, would not be so suitable in mechanics. In fact, it might be more appropriate to refer to this definition as *intrinsic gravitational energy*.

Fine-Grained Internal Torque

III. The fine-grained torque that acts on the constituent atoms and molecules of an atomic clock in a gravitational field increases their intrinsic energy. Additionally, any actual translational motion of the molecules induces a physical reaction that results in a further torque. Compared with the state of rest, this extra convectively induced torque causes a change in the body's intrinsic energy equal to the externally observed kinetic energy, $\frac{1}{2}mv^2$, while the inductive effect due to gravity causes a change in the intrinsic energy equal to, $\frac{1}{2}mu^2$. This gravitationally induced energy, $\frac{1}{2}mu^2$, is like a latent kinetic energy based on the escape velocity. It's a steady state situation analogous to a precessing pivoted gyroscope. In a closed elliptical orbit, both the gravity and the motion effects add together positively, and they both vary in time at exactly the same rate; therefore, the intrinsic energy of an orbiting atomic clock will be maximum at its lowest height and minimum at its highest height.

We now need to establish exactly what translational motion is measured relative to, what the physical interaction is with any background medium, and how any such background medium interacts with gravity.

The Aether and the Electron-Positron Sea

IV. It is proposed that space is densely packed with tiny aethereal vortices that are pressing against each other with centrifugal force while striving to dilate, [1], [2]. Each of these tiny vortices contains both a sink (an electron) and a source (a positron) in mutual orbit, [3], [4]. It is further proposed that the atoms and molecules of ponderable matter constitute more complex vortices. When a body linearly accelerates, the shear interaction between the constituent molecules and the background electron-positron sea (the luminiferous medium) leads to precession of both the constituent molecules and the background electron-positron dipoles, and this has the effect of increasing the fine-grained centrifugal pressure. The change in this internal centrifugal pressure as compared to the rest state is known as *kinetic energy*. Kinetic energy is a pressure which is induced either by acceleration caused by an external force, or when a fine-grained angular acceleration wave emitted from one body delivers kinetic energy into another body during a collision, [5]. When this happens, the other body then linearly accelerates.

It is proposed that gravity is mediated by tensile aether on the large scale, flowing into the sinks in all matter, for a reason unknown, at a speed equal to the local escape velocity, and that in doing so it superimposes on the local flow around and within the tiny rotating electron-positron vortices that fill all of space. There is therefore a prevalent flow of aether travelling radially downwards through the luminiferous medium and into the Earth. The luminiferous medium does not itself flow into the Earth, instead being entrained within the Earth's gravitational field as the Earth orbits the Sun. The luminiferous medium then forms the basis of the Earth centred inertial (ECI) frame. Due to their dipolarity, with the electron being a sink and the positron being a source, these tiny aether vortices that comprise the ECI frame are caused to precess by the gravitational inflow, hence inducing centrifugal pressure to act at right angles to the gravitational field lines. In the case of two mutually orbiting planets, a region of the sea of tiny vortices (luminiferous medium) is entrained within each gravitational field, and the tension that exists at the interface between these two gravitational fields so as to cause mutual attraction, is undermined by centrifugal pressure acting at right angles to the gravitational field lines. The greater the mutual shear velocity between the two gravitational fields, the greater will be the centrifugal pressure emanating from the tiny vortices at the interface. This is centrifugal force on the large scale, and it acts against gravity to push the two planets apart.

Meanwhile, internal fine-grained centrifugal pressure is the basis of all intrinsic energy in atomic and molecular matter, and also in the electron-positron sea. It is the *rest mass* energy, mc^2 , where c is the circumferential speed of a compressed molecular orbit, [6]. In the case of the electron-positron sea, it is proposed that c will be the speed of light, and hence each dipole will have a

stored centrifugal potential energy of 1.02MeV. When a gamma photon supplies an additional 1.02MeV of aether pressure on top of this, the electron and positron in the dipole will then overcome the external centrifugal pressure that was pushing in on them from the surrounding dipoles and hemming them in. The electron and positron in the dipole will hence escape from their lattice bonds, leading to electron-positron pair production, [7].

The Myth of Time Dilation

V. Atomic clocks work on the principle of matching the energy of an incident beam of electromagnetic radiation to the transition energy between two states within an atom, such as a caesium atom. Hence, in a clock that is moving relative to the ECI frame, where the kinetic energy is higher than in the case of a stationary clock, we would expect the intrinsic energy to be higher too, even though the transition energy is lower. But since the precise mechanism is unclear, we are unable to make any certain assumptions regarding the relationship between the increase in the total intrinsic energy and the decrease in the transition energy. If we were, however, to assume perfect inverse proportionality between these two parameters, then comparing equation (1) with the Planck equation,

$$E = hf \tag{3}$$

where h is Planck's constant, we would expect the relevant radiation frequency to obey the equation,

$$f' = f_o(1 - v^2/2c^2) \tag{4}$$

where the negative sign in equation (4) reflects the fact that the frequency, f' , involved in the moving clock is less than the frequency, f_o , in the stationary clock. Meanwhile, equation (4) could also be used with the escape velocity, u , seen in equation (2), for the case of the gravity effect. And since the energy involved in equations (3) and (4) relates to the quantum of electromagnetic radiation that is involved in the transition, then from Maxwell's radiation pressure equation, we can apply $E = mc^2$, where c is the speed of light and m is the mass involved in the associated quantum of radiation, [3].

It should be noted that when v is much less than c , equation (4), being a frequency equation, is only a binomial approximation away from the time equation of the Lorentz transformations, [8]. The latter should therefore ideally refer to the period which corresponds to that frequency, and not to the actual passage of time itself.

Although atomic clocks tick slower when in motion or when placed in a stronger gravitational field, this has no bearing on the actual passage of astronomical time as is defined by the orbit of the Earth around the Sun. Time

dilation, as per Einstein's theories of relativity is a myth. All that happens with atomic clocks in GPS orbit, is that the caesium clock mechanism is physically altered, both by motion of the caesium atoms through the dense sea of rotating electron-positron dipoles that sits stationary within the ECI frame, and by the gravitational inflow of the pure aethereal fluid, flowing downwards through the electron-positron sea, and also through the caesium atoms.

References

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"All space, according to the younger Bernoulli, is permeated by a fluid aether, containing an immense number of excessively small whirlpools. The elasticity which the aether appears to possess, and in virtue of which it is able to transmit vibrations, is really due to the presence of these whirlpools; for, owing to centrifugal force, each whirlpool is continually striving to dilate, and so presses against the neighbouring whirlpools."

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See *section VI* for Maxwell's radiation pressure equation.

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[8] Tombe, F.D., "*The Lorentz Aether Theory*", (2020)

See **Appendix B**.

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