The Shapiro Delay – by "Flamenco Chuck" Keyser

In his paper, Shapiro describes his analysis as based on a scalar-tensor theory (from Brans-Dicke). This paper is a discussion of this idea as presened in the Wiki..

http://en.wikipedia.org/wiki/Shapiro_delay

Briefly, a tensor describes a context in which the quantities represented are independent of each other; that is, are orthogonal (e.g. space-time (x,t) or Energy-Momentum (E,K). Physically, it means there is no interaction between the quantities involved, and they can be represented by the Pythagorean theorem as a circle: $r^2 = x^2 + y^2$ in the space of two dimensions (x,y); this means that x and y can be varied independently, but their relationship will always be in the form of a circle. Note that the "radius" can either describe a one-dimensional "diameter", a two-dimensional "area", or a three-dimensional "sphere", and if time is involved, a four-dimensional "periodic function" Also notice that the process of squaring the radius removes the distinction between "sense", so the origin must be taken at the junction of the centers of the diameters.

In order to analyze the physics, we will need a few equations:

1. The Special Relativistic Energy-Momentum equation is given by the relation $m^2c^4 = P^2c^2 + {m_0}^2c^4$ where m^2c^4 is the total relativistic energy of a non-interacting physical system with its center of mass at a point at which the the speed of light c is defined, ${m_0}^2c^4$ is the unperturbed energy at this point, and $P^2c^2 = {m_0}^2({}^{v}/_{c})^2c^2$ is the Energy of the perturbation, as defined by an energy ratio determined by $\beta = {}^{v}/_{c}$. It is understood that v and c represent energy content, and that inertial "rest" mass is given by the relation $m_0 = \rho c\tau$, where τ is a scaling factor on the energy content of light, and $\rho = 1$ is the particle density at the coordinate origin; it is equal to one, since for the present only one point (physical system) is under consideration. The actual existence of a physical quantity at a coordinate origin must be left to philosophy or religion: that there IS at least one such point is accepted by realists (and even by solipsists occasionally after they stub at least one toe….)

   The equation can be expressed as $E^2 = P^2 + {E_0}^2$, where E_0 is the rest energy, P the perturbation, and E the total energy; note that if $E_0 = 0$, then P becomes the total energy; it is instructive to set each of the quantites to zero in turn to get a feeling for their relationships. The above relation is often expressed by rearranging in order to characterize the perturbation, so that $P^2 = E^2 - {E_0}^2$.

   Consider the quantity $E^2 = (P + E_0)^2 = P^2 + 2PE_0 + {E_0}^2$. Here $2PE_0$ is an interaction term; if it is a result of the above relation then P and E_0 are less than their values in the above paragraph for a given total energy. If P and E_0 have the same values, then the total energy must increase.

If there is no interaction term, then the rest energy and perturbation are either independent of each other, or the "total energy" in which the interaction term is simply omitted is the "dot" product (tensor contraction) forcing independence in the physical context under consideration, and the physical quantities are again linear (i.e., the description of the physical system has been "linearized" to a tensor form.

One effect of the Relativistic Energy-Momentum equation is to remove the "sense" (+/-) quality of the individual components of the energy, so that the total energy of the system can be considered the "radius" of an energy circle, where the area of the circle can be modeled as filled with a continuous density of light so that ${R_0}^2 = {E_0}^2 = (m_0c^2)^2$ which is the Schwarzchild radius of a black hole which interacts with nothing else. A perturbation term implies a new Schwarzchild radius if it doesn't change the total energy is called contravariant, since the parameteers must change; if it does change the total energy, the perturbation is called covariant.

Note that the total value of the energy in the circle can be considered as concentrated at the origin (by a well known theorem), - the function that does this is called a Green's function…

2. The constant energy content of light c (when considered as a unit value) was derived by Maxwell from Gauss' and Ampere's laws, and is expressed in terms of the permittivity ε_0 and permeability μ_0 constants, which are determined by the forces between equal charges and current loops in a homogeneous and isotropic field determined at any common radius in at which they are measured (actually, ε_0 is measured, and μ_0 adjusted to conform to the local value of c, where $c^2 = {}^1/_{\varepsilon_0\mu_0}$.
3. The "Time Dilation" equation describes the relation between a non-interacting "rest" mass m_0 and a perturbation, where the modified mass is given by the relation:

   $m^2 = \frac{{m_0}^2}{\sqrt{1-\frac{v^2}{c^2}}}$. If we define $m = \rho ct'$, and $m_0 = \rho ct$, and set $\rho = 1$, we have the socalled time dilation equation; however this is not really a time in coordinate space, but rather a scaling factor on c that defines rest mass and a perturbation in rest energy-perturbation space: (ct,vt') So that $ct'^2 = vt'^2 + ct^2$. In this context, the various parameters are not considered to be continuous, but discrete, so the above equation should actually be expressed as

   $\Delta c\Delta t'^2 = \Delta v\Delta t'^2 + \Delta c\Delta t^2$ (this is the result of the postulate that v and c are independent variables (v,c), but scaled by t and t' to provide a consistent definition of mass for all possible scaling factors; in this context, the masses are taken to be discrete as well.

4. Burrowing further, we define a specific energy content of light c_0 (and thus a specific rest mass) to be defined for a given "rest" scaling factor $c_0 = v_c = \frac{\Delta x_c}{\Delta t_c} = \frac{1}{\sqrt{\varepsilon_0 \mu_0}}$ We note that the STR postulates that c_0 is a global invariant in space-time; it is the same "anywhere, anywhen" In the following analysis, and in particular at the coordinate origin, which is the only particle in the universe in the present context. (Note: this postulate will be relaxed later on.)
5. For a given perturbation, the ratio $\beta = \frac{\Delta v}{\Delta c} = \frac{\Delta x_v \Delta t_c}{\Delta t_{v\Delta x_c}}$ for a conserved system we can either take the "time" variables to be equal OR the "space" variables to equal, but not both, since that would define a change (an "acceleration") of c, implying the creation of matter. (Note, however, that declaring these variables discrete invoves an "acceleration from zero" as in "let there be light")
    a. In the case where $\Delta x_v = \Delta x_c$ we have $\beta = \frac{\Delta v}{\Delta c} = \frac{\Delta t_c}{\Delta t_v}$ where $\Delta t_v \geq \Delta t_c$, which is interpreted that an inertial object with velocity $v \leq c$ takes longer than a photon to travel the same distance. (This model is used for relativistic quantum field theory)
    b. In the case where $\Delta t_v = \Delta t_c$ we have $\beta = \frac{\Delta v}{\Delta c} = \frac{\Delta x_v}{\Delta x_c}$ so that an inertial object object with velocity $v \leq c$ doesn't go as far as a photon in a given interval of time. (this model is used for quantum gravity).

    If $\Delta v \Delta t' \geq \Delta c \Delta t$. then the description of the system must be modified to include two particles (or four, if sense is to be included as a degree of freedom).

6. The QM Wave Equation

    The Quantum Wave equation is given by:

    $\Psi(\Delta x, \Delta t) = \exp\left(\frac{i}{\hbar}(\Delta P \Delta x - \Delta E \Delta t)\right)$, where $\hbar$ is the energy content of a single cycle (ignoring interference). Since the parameters $(\Delta x, \Delta t)$ are independent of each other the value of either momentum OR energy can be taken by taking the derivative with respect to Δx or Δt respectively. In this context, this implied that ΔE describes the energy at the source and sink (sensor), and ΔP describes the energy during the transition (so position is indeterminate, since any interaction would change ΔP. In this sense ΔE is a "perturbation" (created/destroyed particle, and ΔP describes the particle in its existence between source and sink.

    The classical "Probability" function is described by taking the derivative and its complex conjugate of the wave equation (the complex conjugate removes sense), which is actually a density where

    $$\rho(\Delta x) = \frac{\Delta \Psi}{\Delta x}(\Delta x, \Delta t)^*(-\hbar)\frac{\Delta \Psi}{\Delta x}(\Delta x, \Delta t) = \Delta P$$

    OR

    $$\rho(\Delta t) = \frac{\Delta \Psi}{\Delta t}(\Delta x, \Delta t)^*(-\hbar)\frac{\Delta \Psi}{\Delta t}(\Delta x, \Delta t) = \Delta E$$

Note that this classical formulation removes the energy per wavelength by factoring out $\hbar$ and that if $\Delta P \Delta x = \Delta E \Delta t$ then $\rho = 1$.

The Schwarzchild Radius

The Schwarzchild radius R_s is given by ${C_R}^2 = \frac{2GM_S}{R_s}$, where G is the gravitational constant, $M_R = 2M_s = \rho(C_R T)$, $\rho = 2$ is the total mass of the system (including positive and negative energy), C_R is the energy "speed" of light that defines the Schwarzchild Mass. Here ρ is a particle density which accounts for the fact that both equal amounts positive and negative mass are characterize the model at the center of mass.

If we define $\varepsilon'_0 = {}^1/_G$ so that ε'_0 represents the "gravitational permittivity constant", we can define $\mu'_0 = 1$ to be the gravitational permeability constant, so that (a la Maxwell), $C_R = \frac{1}{\sqrt{\varepsilon'_0 \mu'_0}} = \frac{\sqrt{G}}{\sqrt{(1)}}$. Then $G = {C_R}^2$ and $R_s {C_R}^2 = 2{C_R}^2 M_R$, so that ${R_s}^2 = {M_R}^2 = (C_R T_R)^2$, where T_R is a scaling factor on a given C_R for different values of R_s

We can think of this as a "disk" in "Mass" space, with radius R_s, "area" $A_R = \pi {R_s}^2$ and "circumference" $C_{cir} = 2\pi R_s = 2\pi C_R T_R$. In three spatial demensions, $V_R = \frac{4}{3}\pi {R_s}^3$

The Schwartzchild radius models a Mass "circle" filled with homogeneous and isotropic light at the same wavelength (actually one wavelength; the diameter of the circle). Nothing can escape from the Black Hole, simply because everything is contained in the Black Hole.

If a particle "escapes" from the "Black Hole", then the c.m. where light is defined would change, and the internal parameters would change, but the Schwartzchild radius would remain constant; the transformatin would be "contravariant". However, if a particle is added to the system, the c.m. would change in such a way that the Schwarzchild radius (mass) would change to include the mass of the new particle, and the tranformation would be "covariant".

It is important to emphasize that coordinate space only exists to define the "speed" of light which is identified with the value form the mass-energy parameters of the Schwarzchild radius, so that $C_R = \frac{\Delta x_c}{\Delta t_c}$ when the identity $C_{x,t} = C_R$ is made. In coordinate space-time, the "light" value C_R exists only at a single point (the origin) – the "radius" merely models the total mass at that point. Matter cannot escape such a Black Hole, since the model already accounts for all the matter in the universe (or non-interacting isolated star).

However, since the an analog of gravity is similar to Maxwell's equations, it is possible to model the perturbation of the mass of a Black Hole in the same way as the linear "Lorentz" transform in STR. The Shapiro "delay" is an interesting expansion of the theory, and I will get around to it in the next couple of days as soon I think about it a bit more…..