Extended Lorentz spacetime approach to gravity

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Abstract

In this paper I will present simple model of gravity field not as spacetime curvature but as a motion of arrows or more precise set of vectors from each point of spacetime. It's rooted in special relativity and it extends Minkowski spacetime to three sectors.

Contents

1 Complete rotational Lorentz spacetime

1.1 Extending Lorentz transformation to three sectors

Lorentz transformation [1] [2] [4] [4] [5] are basis of theory of special relativity [1]. They in Einstein [1] interpretation are result of second postulate of his work [1]. Velocity of light has to be constant for all observers as long as they are inertial observers [1]. Einstein did move forward with special relativity [1] by extending it to general relativity. My assumption is that you arrive with same richness of phenomena using only special relativity [1] [2] with few core changes, without invoking curved spacetime metrics. First one is to extend Minkowski [2] spacetime to three sectors not only one sector. This way as Lorentz transformations are hyperbolic rotations [4] [5] that go only by light cone are so to speak fixed on it, extend them to whole spacetime so not only space-like regions but inverse spacetime regions. This means that Lorentz transformations [1] [2] [4] [4] [5] in this view allow for full rotation like in normal space. I will start by writing coordinates of those three regions. If I denote normal coordinates by $x^\mu = (x^0, x^1, x^2, x^3)$ anti-region coordinates are just $\bar{x}^\mu = (-x^0, -x^1, -x^2, -x^3)$ so that relation $\bar{x}^\mu = -x^\mu$ holds true. For space-like coordinates I need to swap space and time coordinates. That can be written as $\overleftrightarrow{x}^\mu = (\overleftrightarrow{x}^0, \overleftrightarrow{x}^1, \overleftrightarrow{x}^2, \overleftrightarrow{x}^3)$, where symbol $\leftrightarrow$ means that i swapped coordinates and now time coordinates act like space coordinates and space coordinates act like time. For example in spacetime interval [2] I can define normal spacetime interval as, where I use mostly plus sign convention:

$$ds^2 = \eta_{\mu\nu} dx^\mu dx^\nu = -\left(dx^0\right)^2 + \left(dx^1\right)^2 + \left(dx^2\right)^2 + \left(dx^3\right)^2 \tag{1}$$

But If I do same but for swapped coordinates I will arrive at minus this expression:

$$ds^2 = \eta_{\mu\nu} d\overleftrightarrow{x}^\mu d\overleftrightarrow{x}^\nu = -\left(dx^1\right)^2 - \left(dx^2\right)^2 - \left(dx^3\right)^2 + \left(dx^0\right)^2 \tag{2}$$

It does not mean that I did change metric sign signature but that space coordinates are now acting like time coordinates and time coordinates are acting like space one. This can be easy written using imaginary unit as relation with normal coordinates:

$$\overleftrightarrow{x}^\mu = ix^\mu \tag{3}$$

It does not mean that those coordinates are imaginary in any sense it's just matter of convention. Key is to make Lorentz transformation [1] [2] [4] [4] [5] go from normal region to swapped region to anti-region back to swapped region then again to normal region so those transformations allow whole rotation in spacetime. This can be written as a scheme:

$$x^\mu \to \overleftrightarrow{x}^\mu \to \bar{x}^\mu \to -\overleftrightarrow{x}^\mu \to x^\mu \tag{4}$$

1.2 Using imaginary unit for changing sectors

Previous scheme can be written simply as normal coordinates multiplied by imaginary unit each time they change sector. That can be written in more clean from as a cycle:

$$i^0 x^\mu = x^\mu \tag{5}$$
$$i^1 x^\mu = \overleftrightarrow{x}^\mu \tag{6}$$
$$i^2 x^\mu = \bar{x}^\mu \tag{7}$$
$$i^3 x^\mu = -\overleftrightarrow{x}^\mu \tag{8}$$
$$i^4 x^\mu = x^\mu \tag{9}$$

That represents full rotation in spacetime. Key change is that space-like region has time and space coordinates swapped so it means that Lorentz transformations [1] [2] [4] [4] [5] don't act on $SO(1,3)$ symmetry but on $SO(3,1)$ symmetry. It means that time has now space directions and it's not a line but a sphere. It means that in spatial sector time belongs to a sphere not a line, it allows for close time-like curves but as I will explore later they are free of paradoxes. This can be summarize in table that deals with whole cycle: Now

n	i^n	Spacetime interval	Sector
0	1	$ds^2_{(0)} = ds^2$	ordinary sector
1	i	$ds^2_{(1)} = -ds^2$	side sector
2	-1	$ds^2_{(2)} = ds^2$	anti-ordinary sector
3	$-i$	$ds^2_{(3)} = -ds^2$	side sector, opposite orientation
4	1	$ds^2_{(4)} = ds^2$	ordinary sector, cycle closed

Table 1: Full sector cycle generated by multiplication by powers of i.

Lorentz transformations [1] [2] [4] [4] [5] go from normal transformations to switched space and time transformations to a opposite sign transformations when going a whole cycle. This again can be expressed as a table: This can

n	i^n	Interval	Sector	Lorentz action
0	1	ds^2	ordinary	$x'^\mu_{(0)} = \Lambda_{1,3}{}^\mu{}_\nu x^\nu$
1	i	$-ds^2$	side	$x'^\mu_{(1)} = \Lambda_{3,1}{}^\mu{}_\nu (ix^\nu)$
2	-1	ds^2	anti-ordinary	$x'^\mu_{(2)} = \Lambda_{1,3}{}^\mu{}_\nu (-x^\nu)$
3	$-i$	$-ds^2$	side, opposite orientation	$x'^\mu_{(3)} = \Lambda_{3,1}{}^\mu{}_\nu (-ix^\nu)$
4	1	ds^2	ordinary, cycle closed	$x'^\mu_{(4)} = \Lambda_{1,3}{}^\mu{}_\nu x^\nu$

Table 2: Full sector cycle and the corresponding Lorentz transformation type.

be summarized in one equation $x'^\mu = \Lambda_{(n)}{}^\mu_\nu i^n x^\mu$, where there is $SO(1,3)$ for even and $SO(3,1)$ for odd n numbers.

2 Vector field acting on space of arrows

2.1 Set of arrows

In this model I will not use a single vector but a set of vectors at each point. This set can be anything as long as it belongs to a three sectors space. Simplest sector is a time-like arrow with zero space like component that is just a one arrow. If there is a set of arrows on a sphere in space and on hypercone in spacetime (not light cone) it represents object moving with constant velocity in given point in all space directions. I will denote set of arrows as X so will use notation for four position vector $x^{\mu(X)}(\mathbf{x})$ where now all four vectors are a fields in space and time. So they can change from event to event. It means that I can write spacetime interval as:

$$ds^2_{(X)}(\mathbf{x}) = \eta_{\mu(X)\nu(X)} dx^{\mu(X)}(\mathbf{x})\, dx^{\nu(X)}(\mathbf{x}) \tag{10}$$

That means that spacetime interval is defined on a set X not a single value of arrow but a collection of them at each point. To understand this concept better I will use simplest position vectors. Let me assume that each point space moves with escape velocity from Newtonian physics. I will first denote four position vectors:

$$x^{\mu(\hat{n})}(r) = \frac{c\tau}{\sqrt{1-\frac{r_s}{r}}}\left(1, \sqrt{\frac{r_s}{r}}\hat{n}^1, \sqrt{\frac{r_s}{r}}\hat{n}^2, \sqrt{\frac{r_s}{r}}\hat{n}^3\right) \quad r \geq r_s \tag{11}$$

$$x^{\mu(\hat{n})}(r) = \frac{c\tau}{\sqrt{1-\frac{r}{r_s}}}\left(1, \sqrt{\frac{r}{r_s}}\hat{n}^1, \sqrt{\frac{r}{r_s}}\hat{n}^2, \sqrt{\frac{r}{r_s}}\hat{n}^3\right) \quad r \leq r_s \tag{12}$$

$$\hat{n}_i \hat{n}^i = 1 \quad \hat{n} \in S^2 \tag{13}$$

Where I did denote black hole radius $r_s = \frac{2GM}{c^2}$, for inside a event horizon I have opposite velocity as in space-like sector moving with infinite velocity is seen as a rest. Now what is missing from this picture is opposite sector I can add it :

$$\bar{x}^{\mu(\hat{n})}(r) = -\frac{c\tau}{\sqrt{1-\frac{r_s}{r}}}\left(1, \sqrt{\frac{r_s}{r}}\hat{n}^1, \sqrt{\frac{r_s}{r}}\hat{n}^2, \sqrt{\frac{r_s}{r}}\hat{n}^3\right) \quad r \geq r_s \tag{14}$$

$$\bar{x}^{\mu(\hat{n})}(r) = -\frac{c\tau}{\sqrt{1-\frac{r}{r_s}}}\left(1, \sqrt{\frac{r}{r_s}}\hat{n}^1, \sqrt{\frac{r}{r_s}}\hat{n}^2, \sqrt{\frac{r}{r_s}}\hat{n}^3\right) \quad r \leq r_s \tag{15}$$

This forms complete spacetime of arrows that are base for testing this model, where it differs from any gravitational theory is that singularity at $r = 0$ is not present as object is just at rest in space-like region. Key here is that it's still a flat spacetime, there is no curvature so spacetime interval will be still Minkowski [2]. That means that object position is more important than spacetime metric and it defines how motion is seen.

2.2 Four velocity and acceleration

I will start by writing four velocity vectors [3] that are just:

$$u^{\mu(\hat{n})}(r) = \frac{1}{\sqrt{1-\frac{r_s}{r}}}\left(1, \sqrt{\frac{r_s}{r}}\hat{n}^1, \sqrt{\frac{r_s}{r}}\hat{n}^2, \sqrt{\frac{r_s}{r}}\hat{n}^3\right) \quad r \geq r_s \tag{16}$$

$$u^{\mu(\hat{n})}(r) = \frac{1}{\sqrt{1-\frac{r}{r_s}}}\left(1, \sqrt{\frac{r}{r_s}}\hat{n}^1, \sqrt{\frac{r}{r_s}}\hat{n}^2, \sqrt{\frac{r}{r_s}}\hat{n}^3\right) \quad r \leq r_s \tag{17}$$

$$\bar{u}^{\mu(\hat{n})}(r) = -\frac{1}{\sqrt{1-\frac{r_s}{r}}}\left(1, \sqrt{\frac{r_s}{r}}\hat{n}^1, \sqrt{\frac{r_s}{r}}\hat{n}^2, \sqrt{\frac{r_s}{r}}\hat{n}^3\right) \quad r \geq r_s \tag{18}$$

$$\bar{u}^{\mu(\hat{n})}(r) = -\frac{1}{\sqrt{1-\frac{r}{r_s}}}\left(1, \sqrt{\frac{r}{r_s}}\hat{n}^1, \sqrt{\frac{r}{r_s}}\hat{n}^2, \sqrt{\frac{r}{r_s}}\hat{n}^3\right) \quad r \leq r_s \tag{19}$$

Now from it I can write a four acceleration [3] vector fields. They are more important as they encode how object changes it's motion. I can write it as:

$$a^{\mu(\hat{n})}(r) = \frac{c^2}{2r}\left(\frac{\left(\frac{r_s}{r}\right)^{3/2}}{\left(1-\frac{r_s}{r}\right)^2}, \frac{\frac{r_s}{r}}{\left(1-\frac{r_s}{r}\right)^2}\hat{n}^1, \frac{\frac{r_s}{r}}{\left(1-\frac{r_s}{r}\right)^2}\hat{n}^2, \frac{\frac{r_s}{r}}{\left(1-\frac{r_s}{r}\right)^2}\hat{n}^3\right) \quad r \geq r_s \tag{20}$$

$$a^{\mu(\hat{n})}(r) = -\frac{c^2}{2r}\left(\frac{\left(\frac{r}{r_s}\right)^{3/2}}{\left(1-\frac{r}{r_s}\right)^2}, \frac{\frac{r}{r_s}}{\left(1-\frac{r}{r_s}\right)^2}\hat{n}^1, \frac{\frac{r}{r_s}}{\left(1-\frac{r}{r_s}\right)^2}\hat{n}^2, \frac{\frac{r}{r_s}}{\left(1-\frac{r}{r_s}\right)^2}\hat{n}^3\right) \quad r \leq r_s \tag{21}$$

$$\bar{a}^{\mu(\hat{n})}(r) = -\frac{c^2}{2r}\left(\frac{\left(\frac{r_s}{r}\right)^{3/2}}{\left(1-\frac{r_s}{r}\right)^2}, \frac{\frac{r_s}{r}}{\left(1-\frac{r_s}{r}\right)^2}\hat{n}^1, \frac{\frac{r_s}{r}}{\left(1-\frac{r_s}{r}\right)^2}\hat{n}^2, \frac{\frac{r_s}{r}}{\left(1-\frac{r_s}{r}\right)^2}\hat{n}^3\right) \quad r \geq r_s \tag{22}$$

$$\bar{a}^{\mu(\hat{n})}(r) = \frac{c^2}{2r}\left(\frac{\left(\frac{r}{r_s}\right)^{3/2}}{\left(1-\frac{r}{r_s}\right)^2}, \frac{\frac{r}{r_s}}{\left(1-\frac{r}{r_s}\right)^2}\hat{n}^1, \frac{\frac{r}{r_s}}{\left(1-\frac{r}{r_s}\right)^2}\hat{n}^2, \frac{\frac{r}{r_s}}{\left(1-\frac{r}{r_s}\right)^2}\hat{n}^3\right) \quad r \leq r_s \tag{23}$$

As it can be seen it gives finite acceleration in $r = 0$ point. That acceleration is equal to $\frac{c^2}{2r_s} = \frac{c^4}{4GM}$ Smaller the mass of object more acceleration that is consistent with black hole picture. Still acceleration on event horizon seems infinite but it's not a true acceleration but Lorentz transformed version I can write simpler acceleration as, that gives just normal Newtonian acceleration and on space-like region it gives constant $\frac{c^4}{4GM}$:

$$\frac{dv}{dt} = \frac{dv}{dr}\frac{dr}{dt} = -\frac{c^2 r_s}{2r^2} = -\frac{c^2\frac{2GM}{c^2}}{2r^2} = -\frac{GM}{r^2} \tag{24}$$

2.3 How objects move in field of arrows

As show before I can recover Newtonian acceleration from this picture. Correct for of that acceleration should be in vector not scalar form so:

$$\frac{d\hat{v}^{(\hat{n})}}{dt} = -\frac{GM}{r^2}\hat{n} \tag{25}$$

So it recovers classical gravity at least to event horizon where afterwords it turns into constant acceleration. Key here is that it's still a relativity [1] so from it follows that observers will change their measurements based on relative motion they have. First I can derive a time dilation in this field as and length contraction:

$$\frac{1}{\sqrt{1-\frac{r_s}{r}}}dt = dt' \tag{26}$$

$$\sqrt{1-\frac{r_s}{r}}dr = dr' \tag{27}$$

Where un-primed coordinates are time and length measured by observer in motion in field and primed coordinates are measured by observer at rest with respect to field or more precise where radius goes to infinity. If I transform those to observer perspective who moves with field it will observe:

$$\sqrt{1-\frac{r_s}{r}}dt' = dt \tag{28}$$

$$\frac{dr'}{\sqrt{1-\frac{r_s}{r}}} = dr \tag{29}$$

That gives values exactly like black hole metric does, but here is just how observer will see it's motion relative to stationary observer very far away. It does not mean that spacetime has curvature but rather that spacetime is seen from two perspectives. For space-like region those equation will change to:

$$\sqrt{1-\frac{r}{r_s}}dt' = dt \tag{30}$$

$$\frac{dr'}{\sqrt{1-\frac{r}{r_s}}} = dr \tag{31}$$

It means that from this model perspective after crossing event horizon object does slow down till it gets to complete stop at $r = 0$. Still space and time switch roles. Acceleration perceived inside event horizon is constant and equal to:

$$\frac{d\hat{v}^{(\hat{n})}}{dt} = \frac{c^2}{2r_s}\hat{n} = \frac{c^4}{4GM}\hat{n} \tag{32}$$

2.4 Energy and momentum

Momentum is just four velocity times rest energy for massive particle it takes form:

$$p^{\mu(X)}(\mathbf{x}) = mc\, u^{\mu(X)}(\mathbf{x}) \tag{33}$$

It does have a norm equal to particle rest mass:

$$\eta_{\mu(X)\nu(X)} p^{\mu(X)}(\mathbf{x})\, p^{\nu(X)}(\mathbf{x}) = m^2 c^2 \tag{34}$$

For massless particles it changes to:

$$p^{\mu(X)}(\mathbf{x}) = \frac{\hbar\omega}{c}\left(1, \hat{n}^{1(X)}(\mathbf{x}), \hat{n}^{2(X)}(\mathbf{x}), \hat{n}^{3(X)}(\mathbf{x})\right) \tag{35}$$

And fulfills massless particle relation:

$$\eta_{\mu(X)\nu(X)} p^{\mu(X)}(\mathbf{x})\, p^{\nu(X)}(\mathbf{x}) = 0 \tag{36}$$

This still assumes that energy of particle is same for each arrow. If it's not the case then equations has to have label for each arrow that is part of set, so equations change to:

$$\eta_{\mu(X)\nu(X)} p^{\mu(X)}(\mathbf{x})\, p^{\nu(X)}(\mathbf{x}) = m_{(X)}^2 c^2 \tag{37}$$

$$p^{\mu(X)}(\mathbf{x}) = m_{(X)} c\, u^{\mu(X)}(\mathbf{x}) \tag{38}$$

$$p^{\mu(X)}(\mathbf{x}) = \frac{\hbar\omega_{(X)}}{c}\left(1, \hat{n}^{1(X)}(\mathbf{x}), \hat{n}^{2(X)}(\mathbf{x}), \hat{n}^{3(X)}(\mathbf{x})\right) \tag{39}$$

It means that each arrow of set has not equal value of momentum. Still momentum can depend on position so I should add energy dependence on spacetime coordinates from it follows:

$$\eta_{\mu(X)\nu(X)} p^{\mu(X)}(\mathbf{x})\, p^{\nu(X)}(\mathbf{x}) = m_{(X)}^2(\mathbf{x})\, c^2 \tag{40}$$

$$p^{\mu(X)}(\mathbf{x}) = m_{(X)}(\mathbf{x})\, c\, u^{\mu(X)}(\mathbf{x}) \tag{41}$$

$$p^{\mu(X)}(\mathbf{x}) = \frac{\hbar\omega_{(X)}(\mathbf{x})}{c}\left(1, \hat{n}^{1(X)}(\mathbf{x}), \hat{n}^{2(X)}(\mathbf{x}), \hat{n}^{3(X)}(\mathbf{x})\right) \tag{42}$$

For example in case of one particle momentum function takes form, where I take example from before:

$$p^{\mu(X)}(r) = \frac{\delta(r)\, mc}{\sqrt{1-\frac{r_s}{r}}}\left(1, \sqrt{\frac{r_s}{r}}\hat{n}^1, \sqrt{\frac{r_s}{r}}\hat{n}^2, \sqrt{\frac{r_s}{r}}\hat{n}^3\right) \quad r \geq r_s \tag{43}$$

$$p^{\mu(X)}(r) = \frac{\delta(r)\, mc}{\sqrt{1-\frac{r}{r_s}}}\left(1, \sqrt{\frac{r}{r_s}}\hat{n}^1, \sqrt{\frac{r}{r_s}}\hat{n}^2, \sqrt{\frac{r}{r_s}}\hat{n}^3\right) \quad r \leq r_s \tag{44}$$

2.5 Types of particles and their transformations

There are only two types of particles in this model , and their respected space and time reversed copies. Those two types are just particles that have a rest state and particle that does not have motionless rest state. Rest state particles simply saying massive particles are simplest kind as they can be all transformed to be at rest. Another type is for example photons as they can't be transformed to be at rest at all. Photons will always form a hypercone after transformation and massive particles will be transformed to set of arrows that all are at rest. This means that I can write massive particles Lorentz transformations as all of their respected set of arrows being in rest:

$$\Lambda^{\mu(X)}_{\nu(X)}\left(\mathbf{x}_0\right) u^{\nu(X)}\left(\mathbf{x}_0\right) = \left(1^{(X)}, 0, 0, 0\right) \tag{45}$$

Where $\mathbf{x}_0$ is a chosen point for doing a Lorentz transformation [1] [2] [4] [4] [5]. For photons so massless particles rest does not exist so I need to define it as a transformation that preserves the hypercone of it. This can be written as:

$$\Lambda^{\mu(X)}_{\nu(X)}\left(\mathbf{x}_0\right) k^{\nu(X)}\left(\mathbf{x}_0\right) = \frac{\omega_{(X)}\left(\mathbf{x}_0\right)}{c}\left(1, \hat{n}^{1(X)}\left(\mathbf{x}_0\right), \hat{n}^{2(X)}\left(\mathbf{x}_0\right), \hat{n}^{3(X)}\left(\mathbf{x}_0\right)\right) \tag{46}$$

Where wave vectors fulfill two equations first they are null [2] so:

$$\eta_{\mu(X)\nu(X)} k^{\mu(X)}\left(\mathbf{x}\right) k^{\nu(X)}\left(\mathbf{x}\right) = 0 \tag{47}$$

And unit vectors are equal to:

$$\hat{n}_{i(X)}\left(\mathbf{x}\right) \hat{n}^{i(X)}\left(\mathbf{x}\right) = 1 \tag{48}$$

It's possible to create particles that could exist that are neither matter particles or light particles. They will have rest velocity equal to any velocity , for example tachions would have infinite velocity as a rest velocity. But those transformations follow same rule they preserve particle type. It can be looked as in light of particle has it's base geometric shape, for massive particles it's just a vector moving in time direction, for photons it's a hypercone where degree between arrows is exactly $\frac{\pi}{2}$ radians in space/time axis. Then Lorentz transformations [1] [2] [4] [4] [5] can rotate and scale axis of of that shape, but they dont change shape itself. Last type are same particles but their reversed in space and time type. They fulfill same rules but with inverses coordinates:

$$\Lambda^{\mu(X)}_{\nu(X)}\left(\bar{\mathbf{x}}_0\right) u^{\nu(X)}\left(\bar{\mathbf{x}}_0\right) = -\left(1^{(X)}, 0, 0, 0\right) \tag{49}$$

$$\Lambda^{\mu(X)}_{\nu(X)}\left(\bar{\mathbf{x}}_0\right) k^{\nu(X)}\left(\bar{\mathbf{x}}_0\right) = \frac{\omega_{(X)}\left(\bar{\mathbf{x}}_0\right)}{c}\left(1, \hat{n}^{1(X)}\left(\bar{\mathbf{x}}_0\right), \hat{n}^{2(X)}\left(\bar{\mathbf{x}}_0\right), \hat{n}^{3(X)}\left(\bar{\mathbf{x}}_0\right)\right) \tag{50}$$

This gives set of all possible particle types and their respected transformation.

3 Adding quantum physics to model

3.1 Wave function of arrows

This model have one big advantage on other gravity models. As it acts on flat spacetime it does not modify quantum field theory itself or quantum mechanics in general only it changes from one arrow to field of arrows. I can write a general wave function of arrows as a coordinate field $\Psi(x^{\mu(X)}(\mathbf{x}))$ it means that wave function does not depend on spacetime coordinates $\mathbf{x}$ but on whole arrow field. It means that wave function fulfill standard quantum physics relations as a probability function for example it's norm:

$$\int \Psi^*(x^{\mu(X)}(\mathbf{x}))\Psi(x^{\mu(X)}(\mathbf{x}))d\mathbf{r} = 1 \tag{51}$$

I for example can write Klein-Gordon equation as:

$$\left(\Box_{(X)} - \frac{m_{(X)}^2 c^2}{\hbar^2}\right)\Psi(x^{\mu(X)}(\mathbf{x})) = 0 \tag{52}$$

Where now derivative operator acts on field and can be written as:

$$\Box_{(X)} = \eta^{\mu(X)\nu(X)}\partial_{\mu(X)}\partial_{\nu(X)} \tag{53}$$

Or I can write Dirac equation in same manner:

$$\left(i\hbar\Gamma^{\mu(X)}\partial_{\mu(X)} - m_{(X)}c\right)\Psi(x^{\mu(X)}(\mathbf{x})) = 0 \tag{54}$$

Those examples are still only to show that in general wave function equation stay same. Only change is that now it all depends on arrows field. Particle and it's gravity field is now not perfectly localized at $r = 0$ position but it's spread across multiple possible position in all space. It means that it's gravity field is in superposition and from it follows that before measurement there are all possible positions of particle as it's location. It means that before measurement particle position is given by all possible states of position $\Psi\left(x^{\mu(X)}(ct, \mathbf{r})\right)$ after it's in only one position $\mathbf{r}_0$. It means that wave function after particle is being found in position $\mathbf{r}_0$ changes it's state to:

$$\Psi\left(x^{\mu(X)}(ct, \mathbf{r})\right) \to x^{\mu(X)}(ct, |\mathbf{r} - \mathbf{r}_0|) \tag{55}$$

So it's centered in position where it was found. Still wave function fulfills it respected field equation it's based on like Klein-Gordon equation or Dirac equation. It's mass function then changes to be localized in that point where it was found.

3.2 Planck scale

Previous model did assume that particles have infinite escape velocity at $r = 0$ it ignores fact that none of know elementary particles is a black hole but still it has a point size. Simplest way to resolve this problem is change escape velocity to be fixed at zero radius. It would mean that I can define new escape velocity that is tuned to Planck scale:

$$v_{\text{Escape}}(r) = \sqrt{\frac{2GM}{\left(r + \frac{2m_P\ell_P}{M}\right)}} \tag{56}$$

This would result in change of β factor to:

$$\beta(r) = \sqrt{\frac{2GM}{c^2\left(r + \frac{2m_P\ell_P}{M}\right)}} = \sqrt{\frac{r_s}{\left(r + \frac{2m_P\ell_P}{M}\right)}} = \sqrt{\frac{2M\ell_P}{m_P\left(r + \frac{2m_P\ell_P}{M}\right)}} = \sqrt{\frac{r_s^2}{rr_s + 4\ell_P}} \tag{57}$$

From it follows that I need at least Planck mass to create a black hole or more precise a event horizon. For Planck mass black hole this event horizon is located exactly at where particle is so $r = 0$ position. For large black holes term $4\ell_P$ is very small so it reduces to normal black hole horizon equation. It would mean that infinite velocity that is predicted by simple Newtonian escape velocity does not hold when taking into account Planck scale. It would mean that there is need for infinite mass to generate infinite velocity so go to Newtonian limit again. And from fact that all particles have finite mass and there is always a finite amount of particles possible it would mean that there is no physical way to reach infinite velocity but still even so model does not brake with it. Acceleration with this correction would be equal to:

$$\frac{d\hat{v}^{(\hat{n})}}{dt} = -\frac{GM}{\left(r + \frac{2m_P\ell_P}{M}\right)^2}\hat{n} \tag{58}$$

And for inside the horizon equation stays same as before. This way of writing escape velocity limits problems with black holes as elementary particles. For example for electron this value of escape velocity is extremely small. For radius equal to zero I get:

$$\frac{GM_e}{\left(\frac{2m_P\ell_P}{M_e}\right)^2} = \frac{GM_e^3}{4m_P^2\ell_P^2} \approx 10^{-16}\frac{m}{s^2} \tag{59}$$

That is very small value and could in principle explain why we don't observe gravity at quantum scale.

4 Gravity as a arrow field motion

4.1 No general field equation

In this model as it follows from fact that spacetime is flat [2] there is not given field equation only just possible motion of field of arrows that belong to one of three sectors. There is no general field equation as any possible configuration of those arrows and any possible set that follows rules given before is a possible way of field configuration from it follows its part of the field. It may seem as a paradox but space of all possible fields can't be define easy as it's a set of all possible shapes and their change in spacetime. Another problem is that arrows point in all direction not in one direction, it may look like a problem but in truth it's not. Points are mapped into a spacetime shapes , or putting it another way space is falling into a point. Gravity field then is seen as motion in all possible directions in all possible points. In general this proposed idea solves one big problem a singularity problem at center of a black hole as it was shown. Model follows special relativity [1] in all it's formalism with additional extension of Minkowski space [2] into two additional regions.

4.2 Laws of special relativity still apply

Still it's based on special relativity [1] [2] so velocity of light stays constant for all observers and laws of physics are same in all frame of reference but with slight change as gravity field is present not as spacetime curvature like in general relativity but us motion of arrows field in each point of spacetime. Use of imaginary units does not mean that spacetime is in any way complex it only means that notation favors use of imaginary numbers and does simplify notation. From fact that model in general does not favor any kind of field it can be used to model kind of interaction like for example electrostatic or electromagnetic forces. It does not mean all of possible field configuration are present in nature but are a possible ways of field configuration.

4.3 Gravity is motion

From all of this follows simple conclusion that gravity can be understood as motion that traces a spacetime shape. This motion is defined from point to point and in each point there can be any shape traced by set of arrows. So this structure is more complex than a normal vector field but still simpler than a tensor field as it needs only one index or set of vectors to define it.

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