GEOMETRIC APPROACH TO PLANCK SCALE FIELD

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Abstract. In this paper i present a try to explain how gravity works on Planck scale and beyond it.

1. Clock and rules as general approach to field

In physics base ideas need to be measured quantities, simplest measuring tools for given space-time is ruler and clock or in general sense a transformation that says how clocks and rules behave. To explain fully a physical field i need both set of rules and clocks (coordinates) and rule how they transform from one frame to another or more precise how they transform from one point of field to another point of field. In general sense field should be independent of how we chose to measure distance by what ruler or clock, so it should be not frame dependent but free of any dependence of chosen coordinate system. Most general approach to field should be field without dependence on how we measure geometry of that field in addition it's only free chosen parameter should be it's energy- so field should be only energy dependent , where energy represents matter in that field. But let's go step back, how do i measure distance in a field? I chose a coordinate system and measure how much distance it takes in that coordinate system from one point of field to another. Field itself doesn't have a coordinate system assign to it, but it's easier to use it to map how field changes. Most general transformation of field is a transformation that gives for each dimension of field a vector that represents that field. But that vector can transform in two ways: contravariant and covariant, if I want to make thinking as general as possible , vector transformation should be same covariant and contravariant way, so field is independent of both how coordinate system is chosen and how chosen objects transform.

2. Coordinate system

Let's say i have a coordinate system F and rules of all possible covariant and contravariant transformations of any vector in that system F^{α}_{β}, i want those transformations to obey few rules, first one is that transformation is symmetric so it has to obey equality:

$$F^{\alpha}_{\beta} = F^{\beta}_{\alpha} \tag{2.1}$$

Second rule is that transformation does work for any number of vectors i want to transform for given space-time, so in this case i took two vectors one in covariant form and one in contravariant form i want to make generalize that transformation for any number of vectors so i get in general sense a transformation: $F^{\alpha_1...\alpha_n}_{\beta_1...\beta_n}$ but for n dimension space-time i need only n vector pairs to fully explain that space-time so for general coordinate system of n dimensions i will get transformation that has n pair of covariant and contravariant vectors. So it's second rule for given coordinate system of n dimensions i have n covariant and contravariant pairs that gives a transformation:

$$F(x^1, ..., x^n) : F^{\alpha_1...\alpha_n}_{\beta_1...\beta_n} \tag{2.2}$$

Now i don't have any information about transformation itself. If i want transformation to be only rules of how long are rules and how fast clocks tick i can use relation with metric tensor. Metric tensor says how fast coordinates change with respect to flat coordinates, i can use change of that is equal to change of my transformation. How it works? If transformation changes fast metric gives slowly changing clocks and short rules that change by short amount, i can write that third rule as equation:

$$\partial_{\alpha_1}...\partial_{\alpha_n} g^{\beta_1\gamma_1}...g^{\beta_n\gamma_n}\partial_{\gamma_1}...\partial_{\gamma_n} F^{\alpha_1...\alpha_n}_{\beta_1...\beta_n} = \partial_{\alpha_1}\partial_{\beta_1}...\partial_{\alpha_n}\partial_{\beta_n} g^{\alpha_1\beta_1}...g^{\alpha_n\beta_n} \tag{2.3}$$

Now i both have a scalar field (coordinate system) and transformation of field in general sense that has to obey three rules i explain before. Still i miss energy dependence of field but i will arrive at it later. Field is now in most general sense a field where only how i measure clocks and rules changes but field itself does not change, so field can be shorten or made longer when i use longer rulers of faster clocks.

3. Field equation

Field is solution to scalar equation that comes out tensors that transform coordinate system. Those coordinates depend only on how coordinate transformation changes thus how field changes. But it leaves out of picture energy let's say i have a general covariant and contravariant tensor that takes two vectors and gives as input their energy, i can write relation between field as scalar equation:

$$\partial_{\alpha_1}...\partial_{\alpha_n} g^{\beta_1\gamma_1}...g^{\beta_n\gamma_n}\partial_{\gamma_1}...\partial_{\gamma_n} F^{\alpha_1...\alpha_n}_{\beta_1...\beta_n} - \partial_{\alpha_1}\partial_{\beta_1}...\partial_{\alpha_n}\partial_{\beta_n} g^{\alpha_1\beta_1}...g^{\alpha_n\beta_n} = g_{\gamma_1\alpha_1}...g_{\gamma_n\alpha_n} g^{\gamma_1\beta_1}...g^{\gamma_n\beta_n} T^{\alpha_1...\alpha_n}_{\beta_1...\beta_n} \tag{3.1}$$

Now i have general transformation rule for field solution to that equation is a scalar field that can be be thought as coordinate system function, it takes n coordinates and transform into number. So let's sum it all up:

1. I take a coordinate system F.
2. I write most general form of transformation of that system that when solved gives back a function of coordinates that generates field.
3. Field itself is a coordinate transformation that takes n coordinates and gives a number.
4. Field itself represents how coordinates transform for a given point.

So scalar field that is key in this equation is a function that transforms n coordinates into number, so how a n coordinates transform for given point of field it's its value. Space-time created out of this function has a metric but not one metric tensor but n ones for n dimensional space-time. Meaning behind it is that scalar function of n dimensions is not a point object so i measure distance not as line but as hyper-volume that function generates. From field equation follows that faster field changes (coordinate system) slower metric tensor does change- so those two are in opposite balance if i use short ruler and slow ticking clock my coordinates need to change by large amount. Or opposite if I use long rulers and fast ticking clocks my coordinates change by small amount.

4. Space-time

From field equation comes that field and metric tensor are in opposite to each other, it means that each object moves in space-time by unit of space and time but that unit is not equal for each particle -faster field moves lower units of space and time it uses so space-time shrinks more so unit in that sense takes a bigger part of space-time. Massless particles move with change of field equal to one over Planck units, it means they form an event horizon when moving but from fact that they have lower than Planck energy they do not form a black hole so horizon is only in form of casual structure. If speed is bigger than one over Planck units (that gives shrink of space-time by Planck units in form of metric tensor) field goes faster than massless particles so it goes back in time from point of view of any observer. This particles moving faster than speed of light travel backwards in time and are key to understand big bang in this model. So there are two key components of understanding space-time, first one is speed of field correlation with metric and it's shrinking by Planck units and second one is energy that particle has and can transfer to another particle or in more general sense energy of one part of field can be transfer to another part of field. Now in previous section i told that space-time interval is no longer a line but a hyper-dimensional volume that connects two regions of field, i can write it formally as:

$$ds^{2n} = g_{\alpha_1\beta_1}...g_{\alpha_n\beta_n}dx^{\alpha_1}dx^{\beta_1}...dx^{\alpha_n}dx^{\beta_n} \tag{4.1}$$

It can be understood as shortest volume that connects two volumes of space-time. Each part of field is understood as scalar coordinate transformation function that has n coordinates so it is an n dimensional object, a hyper-surface. I can connect some part of that hyper-surface with another part by using metric tensor but not one but n ones, where each one represents transformation of two vectors in covariant and contravariant form and in coordinate scalar field one coordinate. Proper time is now not a distance in space-time but a shortest hyper-volume connecting two parts of field that are hyper-volumes themself:

$$\tau^n = \frac{1}{c^n}\sqrt{\int_{S(t)\in R^n} g_{\alpha_1\beta_1}...g_{\alpha_n\beta_n}dx^{\alpha_1}dx^{\beta_1}...dx^{\alpha_n}dx^{\beta_n}} \tag{4.2}$$

So history of object is no longer a line but hyper-volume, i assume space-time interval is in space units that's why i divided it by speed of light. Now i have complete model of space-time let's move to measurement of field.

5. Measurement and quantum physics relation

Solution to field equation is a scalar field, that field can be cut into parts that are closed regions- those regions have same value from it i can create a probability field that is this field relation with quantum physics. When i do measurement part of constant value of field are shrink to some smaller region of space. So measurement does shrink field to smaller size, where probability of that shirking is proportional to value of field in that area. So let me first write integral over a closed region with constant value as sum that gives whole integral over space:

$$\int_{S(t)\in R^n} F\left(x^1, x^2 ..., x^n\right) d^{n-1}x = \sum_k \int_{S_k(t)\in R^n_k} F\left(x^1, x^2 ..., x^n\right) d^{n-1}x \tag{5.1}$$

Where I assume that field has finite size, i don't integrate to infinity. When field has finite size i can create a probability function that is just some part of field integral divided by whole field integral:

$$\rho\left(x^1, x^2 ..., x^n\right) = \frac{\int_{S_k(t)\in R^n_k} F\left(x^1, x^2 ..., x^n\right) d^{n-1}x}{\int_{S(t)\in R^n} F\left(x^1, x^2 ..., x^n\right) d^{n-1}x} \tag{5.2}$$

So when i do measurement field does change, it transforms from being spread out to being focus to smaller region. I can write it as field changing from sum over k to sum over l:

$$\sum_k \int_{S_k(t)\in R^n_k} F\left(x^1, x^2 ..., x^n\right) d^{n-1}x \rightarrow \sum_{l>k} \int_{S_l(t)\in R^n_l} F\left(x^1, x^2 ..., x^n\right) d^{n-1}x \tag{5.3}$$

Where i use more summation parts so field is less spread out each of that processes happens with probability $\rho\left(x^1, x^2 ..., x^n\right)$. So each constant closed region of field when measured is less spread out so it takes more parts to cover whole field and each measurement happens with probability. Now i have field relation with measurement i have full picture of how this field works.

6. Rotational symmetry of coordinate system-spin

Coordinate system is not equal to field itself, it is in true only a way to measure field. Question is how field does respond to rotation of part of field? Spin in quantum physics is one of basics properties of particles, here its how coordinate system reacts to rotation of part of field. If part of field is rotated by angle θ then relation with spin number σ of coordinate rotation is:

$$\phi = \theta\left(1-\sigma\right) \tag{6.1}$$

So i need to use rotation operator on coordinate of coordinate field function that rotates field in direction part of field is rotated, so i can write field in scalar form as:

$$F\left(\hat{R}\left(\phi\right)\mathbf{x}\right) \tag{6.2}$$

$$\mathbf{x} = \left(x^1, ..., x^n\right) \tag{6.3}$$

Where i threat coordinate system as vector that rotation matrix acts on. So when field rotates i rotate coordinate system that field depends on. So whole field equation depends not on normal coordinates but on rotated ones- where i here wrote only solution to field equation dependence. Now second part of spin is that it describe state of particle, but there is no need to add special spin property of field other than coordinate system rotation what is important is probability that comes with it. Field can have a state that is multiply of one half. Now i can write probability of field being in one on another state, where that probability is just normal probability but with rotation operator acting on coordinates and divided by sum of all spin states:

$$\rho\left(\hat{R}\left(\phi_s\right)\mathbf{x}\right) = \frac{\int_{S_k(t)\in R^n_k} F_s\left(\hat{R}\left(\phi_s\right)\mathbf{x}\right) d^{n-1}x}{\sum_{s\in\sigma}\int_{S(t)\in R^n} F_s\left(\hat{R}\left(\phi_s\right)\mathbf{x}\right) d^{n-1}x} \tag{6.4}$$

So before measurement field is in all possible spin states after i goes to one spin state:

$$\sum_{k,s\in\sigma}\int_{S_k(t)\in R^n_k} F_s\left(\hat{R}\left(\phi_s\right)\mathbf{x}\right) d^{n-1}x \to \sum_{l>k}\int_{S_l(t)\in R^n_l} F_s\left(\hat{R}\left(\phi_s\right)\mathbf{x}\right) d^{n-1}x \tag{6.5}$$

Field probability depends on shape of coordinate field, spin states will not always have same probability when sign of rotation changes. Field itself can rotate anyhow so rotation in one direction can be another than in minus that direction, still coordinate system rotation reflects rotation of field and for each spin state has same direction as field rotation.