Universal relativity

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Abstract

We overview the physical aspect of canvas theory and universal relativity.

1 Universal relativity

In order to construct first quantization and define quantum field theories, we introduce the principles of universal relativity. As if any field theory over spacetime satisfy special relativity, any *canvas* theory is supposed to satisfy universal relativity. As a result, quantum behavior is explained by the principle of universality.

(R0) (relativity) All systems of *canvas* represent the physics, equivalently.

(R1) (invariant speed of light) c is invariant in *special canvas*, which is inertial reference frame.

(R2) (equivalence principle) $a = g$.

(R3) (universality) There is invariance in a *tissue* of *canvas*.

Note that the (R1) and (R2) with (R0) are the source of the special and general relativity. We exchanged spacetime with canvas, then treat spacetime as a trivial canvas. (R3) is new, and we call (R0)&(R3) as universal relativity. (UR)=(R0)&(R3) for first quantization is only seeable at non-trivial *canvas*. We interpret uncertainty principle and measurement problem by universality of *canvas*.

Remark 1. Actually, universal relativity (UR) is a generalization of special relativity (SR). So (R1) is part of (R3). In *canvas* theory language, special relativity is the universality of the speed of light in Einsteinism with trivial tissues. For convenience, we separated special relativity for now. The invariance of (R3) can vary upto the physics one wants to describe. We focus on the invariance that is the source of quantum mechanics. We treat that special type of invariance just simply *the* universality for practical reason.

QFT is an amalgamation of quantum mechanics and special relativity. It is a field theoretic description of quantum behaviors such as quantized observables and uncertain observables. Crudely, uncertainty principle provides the ground for the creation and annihilation of particles state. And the calculation is about the amplitudes of given input and output. Even though practical calculations involving effective field theory and renormalization gives satisfying results, there are fundamental mathematical caveats of this perspective such as Haag's theorem.[1] Also there are many problems such as non-renormalizability of quantum gravity and the existence of QCD, etc. We think that difficulties of constructing mathematically rigorous QFT stem from the mismatch of the principles between relativity and quantum mechanics. Basically, statement of relativity holds when there is definite observables to compare between relative reference frames, whilst uncertainty principle says it is not possible to get every observables definite.

To fix it, we want to treat uncertainty principle as a behavior of universal relativity rather than a starting point. We want to explain why uncertain behavior and quantized behavior occurs at the small scale with the language of canvas theory powered by principle of universal relativity. In order to do that we work with *tissue* on the canvas rather than points of manifold as observable set, since we want to speak relativity in the language involving indefiniteness. Field theory is a trivial case of canvas theory in some sense.

Definition 1. *Tissue* of *canvas* is the smallest set of morphisms that universally and relativistically represents the observables in *canvas*.

In canvas theory [2], we defined canvas as category of observable set. And we see physics as a functor from Idea to given canvas. Unlike vector space or points of manifold, observables of physics in our language can be generalized as a morphisms between objects or equivalently Hom functors of given canvas. So tissue can be thought of as elaborate version of physical observables that are entangled each other.

For example, position and momentum can be defined as a vector of phase space $(q, p) \in M$ in Hamiltonian mechanics. When we draw Hamiltonism, instead we draw an exact sequence

$$0 \to P \to (Q, P) \to Q \to 0$$

This can be an example of tissue. One can see this sequence is exact in classical case. We set invariance from this sequence as a source of universality for any canvas transformations. So universality holds on the level of tissues, not on the level of individual observables. In this sense, observables of tissues are entangled. Physical theory satisfy universality when the invariance of tissue is kept via certain canvas transformation. We call such transformation as universal transformation. For quantum version, condensed $\underline{P}$ and $\underline{Q}$ are used to define observables of position and momentum. More are on the following section and the paper Hamiltonism.[3] Note that a tissue can be more than short exact sequence as long as it contains the invariance one wants to study from the world of Idea.

Mathematically, tissue can be considered as certain type of spectral sequence that contains invariance one wants to study. However it is more general than that since we also deal with functors of functors, etc. Since we want to fit our language for physics-only, we invent new terminology with exclusive meaning instead of just using terminology of algebraic geometry and condensed mathematics.

Definition 2. *Texture* is topological and analytical property of *canvas*.

For example, observable set over $\mathbb{Z}$ and $\mathbb{R}$ or condensed set $\underline{\mathbb{Z}}$ and $\underline{\mathbb{R}}$ have all different *texture*. This is nothing but renaming the mathematical nomenclature for physics. In the original terminology in condensed math[2], there are notations like p-liquid modules, solid modules or gaseous modules. In order to avoid confusions, we use terminology from textures of canvas in art. We are going to invent more words to fit our need for physics-only vocabulary and grammar in examples followed.

More details of the principles of universality and their applications will be followed in examples.[3, 4, 5] As we have discussed in canvas theory [2] shortly, physics we want to discuss depends on what canvas we choose and which part of Idea we pick to describe. So we will do some examples to convey the use of universality one by one.

In the rest part of this paper, we give intuitions of how we describe quantum physics by universal relativity with canvas. For intuitional reason, we use geometrical images of canvas and use analogies from time to time. And we give an interpretation about the measurement problem from canvas theory perspective.

2 Universality and first quantization

2.1 Geometrical intuition

Let us give some geometrical intuition of condensed observable set without categorical description. In classical mechanics, world is described by differential geometry. For example, a classical particle's trajectory has a single analytic world line over spacetime as long as there is no singularity. But then at quantum scale, particle behaves as if it has indefinite position and momentum at measurement. Instead of representing observables as a point of smooth manifold and then assuming that observables obey the differential equations, we represent infinitesimal observables by profinite sheaf of a point of observable set.[1] In other words, we use condensed set to represent the infinitesimal observables such as $\dot{q}$. See the figure 1 below.

So in canvas theory of Lagrangeism, configuration space is geometrically represented by $(q, \tilde{q})$, not by $(q, \dot{q})$. $\tilde{q}$ becomes $\dot{q}$ when the essence is trivial. Universality works on the *thickness* of $(q, \tilde{q})$. When q has 0 *thickness* $\tilde{q}$ must have invariant *thickness* and that is where uncertainty comes from. This idea can be viewed from the calculus perspective. It is done by redefinition of infinitesimals. We call that perspective as condensed calculus. Or more generally, observables of tissues can have *thickness* in it. It is different from an observable as a point of vector space. Algebraically, a point of

[1] It is another way to define condensed set.[6]

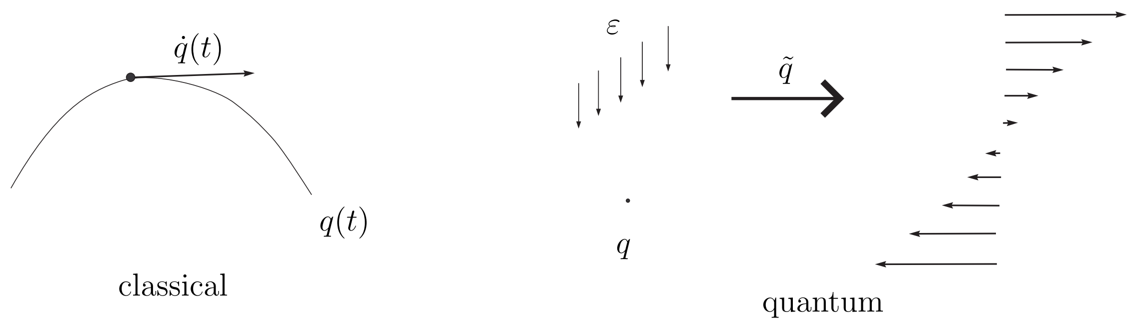


Fig. 1: Tangent vector of quantum mechanics in condensed module.

scheme can have more structures in it depending on which base ring is used. Non-trivial canvas can have more peculiar points in it. In this perspective, we call the study as spectral spacetime.

2.2 Physical intuition

Let us first give some tedious explanation of how the universality works to construct the quantum mechanics and answer the measurement problem. From physical point of view, universality is used to define new observables when there is some invariance in tissues. One example is Einsteinism and the other example we construct is first quantization. Simply put, universality of Einsteinism is such that when there is invariance of speed of light in Idea, there is universal transformation that gives an invariance of interval of light to every reference frame. This means that no matter what reference frame one chooses, the speed of light on it is the same. For quantum mechanics, our observable set is more than smooth manifold and it has multiple arrows in it. Universality of this picture is, let's say, the thickness of the arrows. No matter what essence one choose to take as an observer's point of view, the observer still measures the thickness of morphisms to be invariant. So as long as the canvas is inside of the whole universal family, the canvas is legitimately represents the Idea in it's picture.

Other intuitional but somewhat misleading explanation is from the analogy of brush on the canvas. This is something about for pedestrian version of explanation, we hope the readers do not take it too seriously. Let's imagine as if a particle's trajectory is a drawing of a line on space. Classically, the brush used is a point like object. So the line follows the equation of motion, in Newtonism. However assume that the brush has hairs on it's tip. From far apart, the line still looks like a single line. When magnifying small area of the tip, the trajectory is no more single line, since each hairs are drawing it's own lines. These each single hairs can be thought of degree of freedom on deeper essences. Assume there is a limit on the resolution of canvas due to technical reason. Actually, in real world the resolution of position depends on the wavelength of the observing beam. So the position observable is basically written by the grid of observing

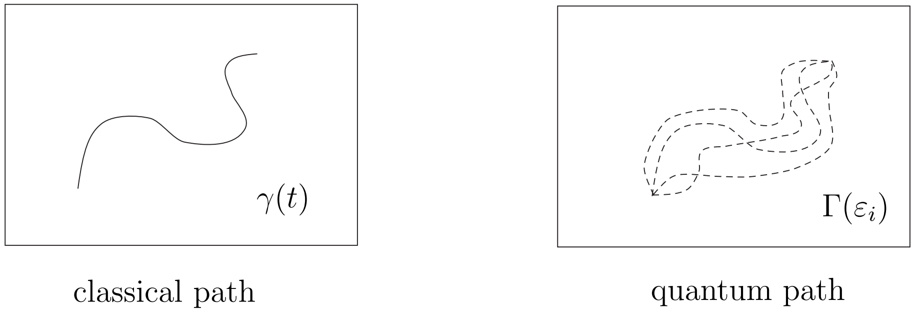


Fig. 2: A particle's path depends on the brush.

beam. If the whole resolution of a particle state is constant, then by stepping up one of resolution of information, one loses the resolution of the other information.

In the brush and canvas analogy, when one side of brush is pin pointed by the observing beam that transforms the canvas itself, the other side of brush is split. Physically, one can say that the entropy of a particle state is invariant no matter what type of observation is done to it. Mathematically, we define observables by tensoring certain base ring such that it's tissue satisfies universality. The resolution of observable set depends on the base ring. In this sense, we are going to explain quantum measurement problem.

3 Observables, tissues and measurement

Category of observable set satisfies the universality on the level of tissue. So tissues are basic building blocks of physical observables. This is unlike classical case, where vector space of observables can be independently defined and calculated. Once any set of observables are connected in a tissue, they are correlated to each other for the universality of the tissue. Here are some examples of tissues.

3.1 tissue of spacetime

For example, let's represent spacetime as a map such that

$$x_0 \xleftarrow[dx_0]{} X \xrightarrow{dx_i} x_i$$

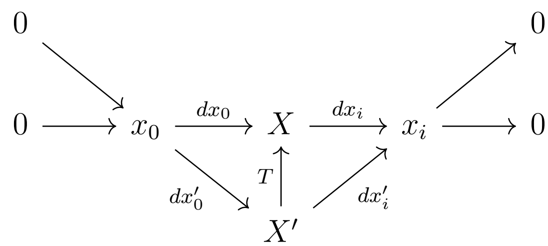
When this map forms a tissue we represent it as a sequence such that[2]

$$0 \longrightarrow x_0 \xrightarrow{dx_0} X \xrightarrow{dx_i} x_i \longrightarrow 0$$

Then by universality, there is another observer that observes the same object in

[2] dx_0 in the tissue is dual of observable above. In this example, let's just skip this technicality.

relativistic motion such that



By universality and couniversality both observables are defined upto Lorentz transformation T and dX. The invariance of both tissues are the spacetime interval such that

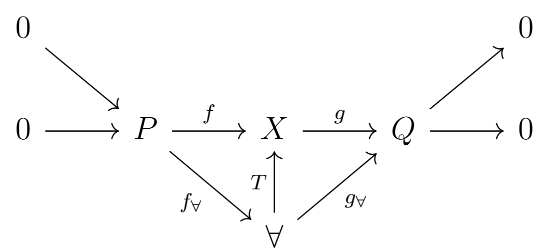
$$dS^2 = -dx_0^2 + dx_i^2 = dS'^2 = -dx_0'^2 + dx_i'^2, \quad (c = 1)$$

3.2 tissue of pomentum

For example, a tissue of pomentum space X (position + momentum) is as follows.[3]

$$0 \longrightarrow P \xrightarrow{f} X \xrightarrow{g} Q \longrightarrow 0$$

The universality of this tissue, which is the amount of indefiniteness,[4] should be kept on the transformation. So any universal transformation changes the canvas into the other observer's point of view such that



The $\forall$'s observables $f_\forall$ and $g_\forall$ are defined by the composition of this map. Note that $g_\forall$ is universal and $f_\forall$ is couniversal. Both observables depend on the former observable f and g. So any transformation T, which is a measurement in quantum case, should satisfy that the transformed tissue to keep the invariance. In this description, we set observables as definite f and g. As we change the observables by indefinite $\underline{f}$ and $\underline{g}$, and define the indefiniteness as $||\underline{f}||$ and $||\underline{g}||$. Then the quantum invariance is the total sum of indefiniteness such that $inv = ||\underline{f}|| + ||\underline{g}|| = ||\underline{f_\forall}|| + ||\underline{g_\forall}||$.[5]

[3] Classically, it is phase space. In order to emphasize the correlation between two observables and the different *texture*, we invent the terminology.

[4] It is zero for classical physics. We also call it the depth of essence.

[5] $||\cdot||$ is the measure of indefiniteness. It is defined by the base ring chosen.

3.3 *Interpretation on measurement problem*

From the above pomentum tissue picture, when measurement occurs then tissue transforms up to the observer's relativistic perspective. The newly transformed tissues satisfy the invariance again. New observables of tissue depends on the measurement T uniquely and the former observables. In case of Einsteinism, this transformation is Lorentz transformation, but in case of quantum mechanics this is universal base transformation.[6] One of observables depends on the observer's detection capability, and that detection changes the property of tissues by resetting the base field. If the observer watches the object with high energy photons which gives fine grid on position observables, the momentum observable gets indefinite.[7] So the observables depend on the change of the texture of tissues. The observer must chase the canvas transformation by different observations, because that is how the observables are defined via universal transformations.

Let us give an intuitive and heuristic version of the interpretation of measurement problem. Suppose the observer detects a position observable first, then it means the tissue of observer is sharper in position observable and crude on momentum observable. Note that this texture as position texture T_{pos}. Tissue with certain texture will be defined with more elaborate algebraic number fields but let us do that in specific examples. In this paper, let us just use the set theoretic argument. Here suppose the T_{pos} is a sequence such that

$$T_{pos} \equiv \quad (0 \to P_{F_0} \xrightarrow{f} M \xrightarrow{g} X_{F_\infty} \to 0)$$

$$\{p_1, p_2, \cdots\} \in P_{F_0}, \quad \{x_1\}, \{x_2\}, \cdots \in X_{F_\infty}$$

Then the measurement by momentum tissue T_{mom} is as follows

$$T_{mom} \equiv \quad (0 \to P_{F_\infty} \xrightarrow{f} M' \xrightarrow{g} X_{F_0} \to 0)$$

$$\{p_1\}, \{p_2\}, \cdots \in P_{F_\infty}, \quad \{x_1, x_2 \cdots\}, \in X_{F_0}$$

Consider $\{x_1, x_2, \cdots\}$ as a full subset of observable set X, and $\{x_1\}, \{x_2\}, \cdots$ as each element of observable set X. In the perspective of observables, when the set is full subset then there is only one map to calculate. However if X contains more elements then there is multiple maps that universally define observable g.

Schematically for only position observables, the measurement of position then mea-

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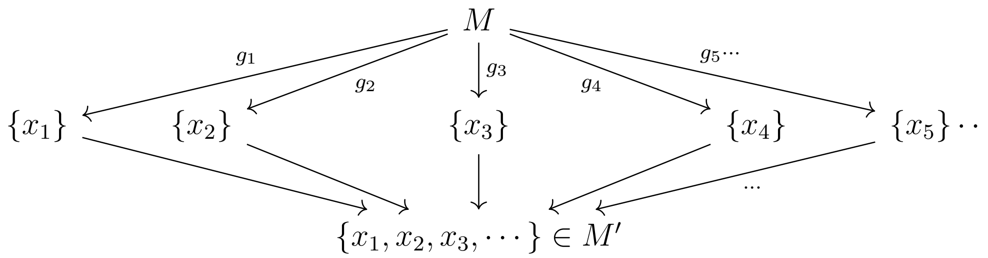
[6] In a perspective of base change, Lorentz transformation is commutative basis vector change, while in quantum case, base field change is non-commutative.

[7] In the analogy of brush and canvas, the hairs are more pointed on position observables while hairs on the momentum side splits.

surement of momentum can be a diagram chase such that



In this perspective, quantum observables are read on g_n. And the amplitudes are defined by giving amplitudes on each observables. So, the act of measurement determines the texture of tissue, then the observable is determined by one of many possible universal observables. This explains how the act of measurement changes the quality of observables. And there is no need to worry about the missing possibilities since they are absorbed in other part of tissue, in this case momentum observable. Also the superposition of observables can be explained by allowing subset, not element of set, to become an physical observable.

This can be spoken more algebraically, and that is how we are going to construct quantum version of physics. In case of special relativity, one changes the basis vector of the other observer's observables by the relative motion. Also in general relativity, non-trivial metric tensor is defined by energy-momentum tensor. In universal relativity, we change the base ring of observables to include the concept of indefiniteness. Classically, observable is defined by a function from real number $\mathbb{R}$. We use quantum observable as a function from essence to some base field. In UR, we change the base field upto the observer's act of measurement. And that defines the tissue on which one tries to measure the observables.

Lastly, another explanation can be made from the light cone analogy. See the figure 3 below. Suppose there is some invariant that restricts the observables of canvas theory. Then one can draw a cone such that the observables are inside that cone, with the maximum possible observable at the boundary. Then there is a universal cone that represents tissues inside. The diagram of light cone is used to represent the possible motion of point of spacetime. In a similar sense, our universal cone represents the possible change of tissues of canvas. But there is no definite strict line as a trajectory in the canvas case, since the infinitesimal observable is not defined as a definite tangent vector but by a universal family of tissues. It is probabilistically determined on the middle line from many possible observables of canvas.

As if light cone restricts physical observables such as time-like observables, universal cone restricts the observable inside the cone. Unlike light cone, the trajectory inside is not definitely defined before universal transformation changes the tissue. The result will be one of points in the middle line. The angle is invariant which can be considered as the amount of indefiniteness.

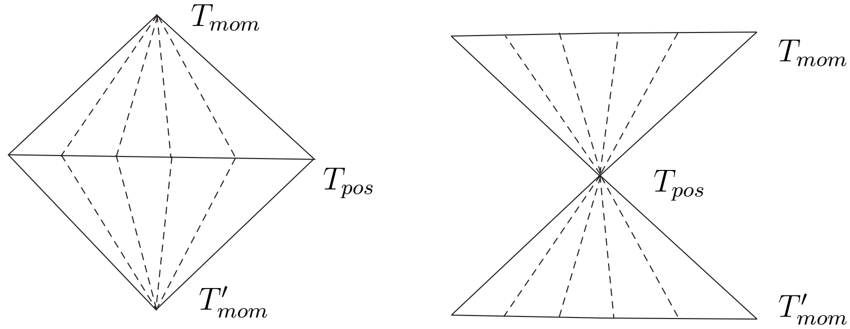


Fig. 3: Universal cone for position observables (left) and momentum observable (right). One of points at horizontal line represents the observables of tissue.

In the next paper we give an example called *Qubitism*.[4] We study the qubit system by canvas theory. We treat it as a toy model before we construct Lagrangeism and Feynmanism. One can taste a flavor of how we use base field change as the universal transformation to construct the physics of quantized spin.

References

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