Unfolding the space of theories

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Abstract

It is argued that a space of theories where all three fundamental constants of nature are involved, necessarily is based on prior flat geometry. There is no dynamic metric, rather spacetime itself is the conjungate degree of freedom to the gravitational field. Consequently, the Unruh effect is nought.

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1 Unfolding the space of theories

As from 1905, there have been left two fundamental dimensionful concepts: Spacetime and energymomentum. Planck mentioned his constant h in union with Newton's constant G as quite obvious candidates for conversion factors to pure numbers. However, the role of fundamental units has remained miracolous [1].

The paper [2] reflects the state of knowledge. If it is assumed that all measurements factually are in terms of spacetime quantities, then only one fundamental conversion factor is needed to measure energymomentum as well. In concrete terms, the authors present the G-protocol and the h-protocol as alternatives: A mass m can either be estimated in terms of its

Schwarzschild radius $r_s = 2Gm$ or in terms of its de Broglie wavelength $\lambda = \frac{h}{m}$ (the velocity of light is set unity). The redundancy is obvious from the relation $r_s\lambda = 2Gh$. This implies that the space of theories spanned by G and h collapses as is shown in Figure 1 of [2].

Already from the pictorial representation it is clear that a collapse of the space of theories is not sensible. In fact, any dimensionful physical concept eventually must appear in terms of information [3] which is a pure number, hence both fundamental units have to enter the game. The reference [2] derives a nonsensical result by means of logically clear analysis - what implies that it falsifies the broadly backed premise. Despite of all the quantiative success of the Riemann-Einsteinian approach in parts of the external parameter space, its basic idea cannot be correct. It is the restriction to the intrinsic properties of a manifold which makes the space of theories collapse and inhibits the quantization of gravitation. Factually, the primary objects of measurement are not spacetime distances, rather these are bits of information.

The residence for the concept of information is phase space. Quantum physics brilliantly teaches that not an n-dimensional Lagrangian submanifold is sufficient to describe physics, rather the full $2n$-dimensional volume of phase space is relevant. This can be formulated in terms of uncertainty relations or equally in terms of a commutator algebra and the underlying symplectic structure. Consequently, in place of the above redundancy relation must come an uncertainty relation. However, there is a fundamental difficulty: On the r.h.s. stands the square of a length (the Planck length squared apart from a trivial numeric factor), while two lengths cannot form a pair of conjungate variables. Fixing this problem means *unfolding the space of theories: The gravitational scale is rearranged in phase space in a direction orthogonal to spacetime.*

In the limiting case where gravitational effects are neglected, λ can easily be understood in terms of an uncertainty. Without loss of generality the massive object shall be at rest relative to the observer, so the wave only oscillates along time x^0, while it is uniformly smeared out all over space. It makes no sense to have an object living shorter than for the duration of one oscillation, so $\lambda = \delta x^0$.

Before dealing with the other limiting case where only gravitational effects are regarded, the phase space - in a somewhat extended sense what regards the inclusion of time - is to be constructed. This is achieved by treating the gravitational field as energymomentum (not a density) of gravitation itself. $z^\mu = x^\mu + \imath\ell A^\mu$ is introduced together with the hermitian metric $g = \eta \otimes \mathbf{d}z \otimes \mathbf{d}z^*$, where the x are the 4 macroscopic spacetime degrees of freedom, ℓ essentially is the Planck length, A is the gravitational field and η is the Minkowski metric. As a crucial point, this phase space has prior flat geometry, and I shall explain the reasoning behind in the next section. Certainly this construction will be doubted, since it is diametrally against the current picture in almost every aspect. There is a clear test, whose experimental realization is not far away. A constant gradient of the gravitational field is achieved or removed by a rotation or boost in the embedding space, what is a global coordinate transformation. This implies that *the Unruh effect is nought*.

On this basis, it is quite straightforward to derive the classical gravitational field equations from an embedded extremal phase manifold determined by the 4 embedding equations $A^\mu(x^\nu)$ varied in terms of the embedding space coordinates and their derivatives. For clarification it shall be added that with the cosmological aspects included in the considerations, the role of the variables turns out to be a bit different from the above. This however is of minor relevance here, and the same holds for the concrete coupling to the sources. The only particular aspect needed is the static isotropic solution. In place of the quasi-Newtonian $\frac{\mathrm{d}A^0}{\mathrm{d}r} = \frac{Gm}{r^2}$ comes the obvious modification $\frac{\mathrm{d}A^0}{\mathrm{d}r} = \frac{Gm}{\sqrt{r^4+\ell^4}}$, where r is the distance from the source. This makes the field finite at the source point, hence $\delta A^0 = A^0(\infty) - A^0(0) = const \cdot \frac{m}{m_{pl}}$, where m_{pl} is the Planck mass and the constant is a pure number of order of magnitude unity.

To sum up, in the pure quantum limit the uncertainty in time was brought in connection with the length of the wave, while in the gravitational limit the uncertainty in the potential was understood to originate from its variation over the radius. For the general case, as the central conclusion *spacetime itself is conjungate to the gravitational field* (this holds locally, while the global aspects will come up with the cosmological picture). In their terms, the uncertainty relations read $\delta A^\mu \; \delta x^\mu \geq const \cdot \ell$ for any $\mu = 0, 1, 2, 3$, where the constant is order of magnitude unity. While the argumentation involved a source of the gravitational field, the uncertainty relations can be abstracted as being a property of the 8-dimensional gravitational phase space as such.

2 A lesson from information theory

Due to reductionism, all natural phenomena can be reduced to the laws of physics [4], what however is not yet the end of the story. In particular with his set of fundamental units, Planck laid the foundations for a modern view on nature reckognizing that *physics is mathematics of information.* Indeed, the concept of information is omnipresent in modern theories like in the entropy of black holes, entanglement, information loss [5] and so on. However, it has not yet been treated in line with the aspects of reductionism. This - not exhaustive - list of implications emerges unevitably if this point of view is taken:

- Information is a pure number. Any physical effect is in terms of pure numbers. Dimensionful physical concepts have been introduced because of ignorance, but oftenly are welcome for practical reasons. There are exactly as many fundamental dimensionful physical units as dimensionful concepts introduced.

- Pure numbers are not scale invariant. Information - which is the number of degrees of freedom of a system - is absolute and cannot be redefined by a change of scale. The freedom to choose physical units is a chimera that can only be retained to the extent to which the description of nature is incomplete.

- Pure numbers are prior to physics, as in particular the notion of time is unknown to mathematics. Physics exists and is to be formulated with reference to a nondynamic prior background.

- The background defines the zero point of information. By itself, it is void of information to the maximum possible. To the extent to which diffential geometry is relevant, this background is a flat space, unbounded and free of topological effects. Even the coordinates are prior cartesian since the generation of the (pseudo)unit matrix field needs the shortest code.

- Information resides in phase space. The background space is to be interpreted as phase space whose global symmetries unambigously gauge information. Embedded submanifolds may show nontrivial intrinsic and extrinsic curvature, producing differential geometric effects as well as topological effects.

Though not immideately relevant for the above, it is highly instructive how the prior existence of a flat embedding space reopens the case of the velocity of light. Even if General Relativity was the correct universal description of gravitation, such a prior space would exist due to a mathematical theorem: Any intrinsic curvature can be produced from embedding in a flat space of sufficient number of dimensions. Flat embedding is indeed how Gauss was led to the idea of curvature, intrinsic as well as extrinsic. In this embedding space, symmetries are global with the translations trivial as is necessary to gauge information. What ever the physical interpretation of the flat embedding space may be, the slopes of singular straight lines have to be set global unity there, else the connection to the concept of information is wrong. Consequently, embedded intrinsically curved manifolds show what one can call a “variable speed of light” - a pure number - at the sufficient level of abstraction.

References

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