

Units are unique

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Abstract

It is argued that the set of physical units is uniquely determined from the set of dimensionful concepts introduced. The basic concepts of spacetime and energymomentum can be interpreted as degrees of freedom in complex phase space equipped with the Minkowski metric.

PACS:

Key words:

Economic life requires to compare apples and oranges in terms of a unique currency - money talks. Intermediate units drop out there and then where they are introduced. With the minor exception of a global rescaling of the monetary unit by the government, the system has no degree of freedom.

The question about physical units and dimensionful fundamental constants [1, 2] appears to be of the same kind. While space and time had been regarded as fundamentally different, Special Relativity teaches that the velocity of light is a rigid exchange rate, so actually there is a common currency.

Quantum physics teaches that Planck's constant is a rigid exchange rate between action as the fundamental dimensionful entity, and information which is a pure number by its very meaning. Hence, like reductionism [3] sees chemistry essentially as physics of atomic bonds, *physics can be seen as mathematics of information*. The concept of information can well exist independent of any observer. In particular, there are preferred bases for the exponential function, namely the number 2 as the smallest integer doing the job as well as Euler's number. In contrast, a basis of 10 induced by human anatomy has no preferred role.

While presumably the majority of physicist would agree on the key role of information, noone has persued this towards the consequences. The reason is that converting all physical quantities to pure numbers receives a dramatic setback when Newton's constant enters the scene. In General Relativity, Newton's constant converts the stress-energy density to the Einstein tensor with dimension of inverse length squared. This weird role is totally different from the transparent role of the velocity of light inside a line element as well as from the transparent role of Planck's constant as a unit of the phase space volume.

It is quite straightforward to conjecture which conversion Newton's constant rather should accomplish, namely between spacetime and energymomentum (both possibly with an extended number of dimensions) inside a line element in phase space. From the mathematical point of view, this is straightforwardly compatible with the role of Planck's constant since phase space is intrinsically complex as is manifested by the ladder operators $a, a^+ = p \pm ix$. In this expression the symbols can have standard meaning, while I already used Planckian units so that all the quantities are pure numbers. A complex space \mathcal{C}^n , where n is the number of dimensions, can be equipped with a hermitean metric. This makes it a Kaehler manifold where Riemannian and symplectic structure coexist through the complex structure $h = h_{ik}dz^i \otimes dz^k$. For brevity, I shall always speak about the "metric" what refers to h_{ik} .

On this basis, the following - not exhaustive - list of consequences from bringing together the ideas of information theory and reductionism, can be dealt with:

- Information is a pure number. Dimensionful physical concepts are unnecessary and had been introduced because of ignorance, but can well serve practical purposes where no direct connexion to information is needed. There are exactly as many fundamental dimensionful physical units as dimensionful concepts introduced.
- Pure numbers as elements of the respective real or complex fields are not scale invariant. Information as the number of degrees of freedom of a system is absolute and cannot be redefined by a change of scale. The apparent freedom to choose units is a chimera reflecting the incompleteness of current theoretical physics.
- 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. Hence 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.
- The global symmetries of the background unambiguously gauge and transport units. Embedded manifolds may show nontrivial intrinsic and/or extrinsic curvature, producing differential geometric effects as well as topological effects.

To conclude, there is a prior space \mathcal{C}^n with a sufficient number of dimensions, that can be interpreted as phase space. The metric is trivial apart from indefiniteness, with a minimum of 3 spacelike and 1 timelike degrees of freedom present.

The plausible this consideration is, the diametrically it stands against General Relativity. So, can it be right? I argue that the answer is yes. First, history of physics teaches that eventually those premises turn out as inappropriate which have been regarded as the most firm ones both for philosophical reasons as well as for their apparent quantitative success. Background-independence is the current most pertinent pre-judgement. Efforts are made to hide the background where it is present naturally, like in

string and membrane theory. Second, the current description of gravitation is responsible for theoretical physics being incomplete. The concept of a fundamental dynamic metric is quantitatively successful in some parameter region for yet uncomprehended reasons, however it falls flat when facing the vacuum and the quantum.

Even if the theory of gravitation was left untouched, there would emerge an illustrative consequence from the above. The role of the velocity of light is ultimately transparent if spacetime is flat, while it remains obscure if spacetime is curved as the discussion on a variable speed of light (VSL) [4] reflects. Now a mathematical theorem proves that a flat embedding space of sufficient number of dimensions *exists* (no other way of existence but this) so that any intrinsic - and extrinsic, of course - curvature can be produced from embedding [5]. To treat information correctly, the “velocity of light” must be set globally unity in the flat embedding space. Consequently it varies in any embedded manifold other than an intrinsically flat one. The opening angles of the null cones - these are pure numbers - emerge from the embedding equations whose role exactly is to encode the shape of the manifold. This means that the current declaration due to which the velocity of light is locally unity inside spacetime (apart from a global factor originating from history) [6] cannot be retained if theoretical physics shall be made complete.

References

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