Basic quantum field theory

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Abstract

The ingredients of basic quantum field theory were discovered in the eighteenth century. In those times quantum physics played no role. In the twentieth century, these ingredients were forgotten and stayed ignored.

This paper introduces two categories of super-tiny dark objects that represent the most basic field quanta. Warps represent a tiny bit of energy. Clamps represent a tiny bit of mass. In separation, these objects cannot be perceived. They are the tiny dark objects that science is still missing.

Introduction

Quantum field theory requires a continuum that can be deformed or vibrated and actuators that cause this deformation or vibration. Next the activity of these actuators must be quantized. Thus, the strength of the deformation or vibration occurs in a set of fixed values. Deformation or vibration can be temporarily or persistent.

Field dynamics

A continuum can be described by a function for which both the parameter space and the target space are multi-dimensional. Dynamics requests a progression parameter and the spatial part requests a multi-dimensional spatial parameter. Quaternions have the advantage that they combine storage for the progression part and for the spatial part and defines a multiplication procedure for the combination of the two. Quaternions can also store the scalar part and the vector part of the target value of a quaternionic function. Quaternions can describe the behavior of dynamic fields via quaternionic differential calculus. Partial second order differential equations describe the interaction between point-like artifacts and quaternionic continuums.

The combination of a quaternionic infinite dimensional separable Hilbert space and its unique non-separable companion Hilbert space that embeds its separable partner offers the playground where this interaction can take place. This playground stores separate quaternions in eigenspaces of operators that reside in the separable Hilbert space and can store quaternionic continuums as eigenspaces of operators that reside in the non-separable Hilbert space.

A subspace that scans this base model as function of a selected progression value represents the static status quo of the model and splits it in a historical part, the current static status quo, and a future part.

The embedding maps the discrete quaternions onto an embedding continuum. The embedding process occurs inside the scanning subspace.

Solutions of the differential equations

he dynamic solutions of the homogeneous second order partial differential equations do not occur spontaneously. They are generated by actuators that determine what kind of solution is generated. For example, a periodic harmonic actuator causes wave solutions of a homogeneous second order partial differential equation, which is therefore known as the wave equation. Also, another, quite similar homogeneous second order partial differential equation exist that does not offer waves as its solutions. This equation splits into two first order partial differential equations. Both homogeneous second order partial differential equations offer solutions that are triggered by one-shot actuators that generate shock fronts. These solutions occur in two versions. ***Warps*** are one-dimensional shock fronts that during travel keep their amplitude. ***Clamps*** are spherical shock fronts that quickly fade away because their amplitude diminishes as 1/r with distance r from the trigger location. In the meantime, clamps integrate into the Green's function of the carrier field. This means that they temporarily deform the carrier. Warps carry a standard bit of energy and clamps carry a standard bit of mass. This makes them the most ***basic quanta*** of the carrier field.

Super-tiny dark objects

Warps and clamps form two categories of super-tiny objects that in separation cannot be perceived. Only organized in huge collections these objects become observable. For example. If emitted at equidistant instants, the warp strings become a frequency, and if these strings obey the Einstein-Planck relation, then the strings implement the functionality of photons.

If recurrently regenerated by dense and coherent swarms of hop landing location triggers, the clamps become noticeable as elementary particles. Less coherent assemblies of warps can create a noticeable amount of ***dark energy***. Less coherent assemblies of clamps can create a noticeable amount of ***dark mass***.

Elementary particles are elementary modules. Together these elementary modules generate all other modules and the modules construct modular systems.

Ensuring coherence

Mechanisms that apply stochastic processes that own a characteristic function generate a hopping path and a hop landing location swarm. The characteristic function acts as a displacement generator and ensures that a coherent swarm is generated that moves as a single unit. The location density distribution of the swarm is the Fourier transform of the characteristic function and equals the squared modulus of the wavefunction of the object that the swarm represents.

The generated swarms represent elementary modules. They show both particle and wave behavior. The characteristic function of the stochastic process explains the wave behavior.

Elementary modules reside on private platforms that own a private parameter space that is generated by a version of the quaternionic number system. The platforms float over a background parameter space that is generated by the version of the quaternionic number system, that the Hilbert spaces use to define their inner product. The differences in ordering symmetry between parameter spaces give rise to symmetry-related charges. These charges locate at the geometrical centers of the platforms and produce symmetry-related fields.

The elementary modules inherit the properties of the platforms on which they reside. In this way, a range of different elementary modules exist

Modules and spectral binding

Together the elementary modules constitute all other modules and the modules constitute modular systems.

Also, the footprints of modules are generated by stochastic processes that own a characteristic function. Therefore, the modules also move as a single unit.

The characteristic function of the module equals the superposition of the characteristic functions of the components of the module. The superposition coefficients determine the internal locations of the components. These coefficients may oscillate.

The superposition installs a very strong kind of spectral binding.

Gravity and attractive symmetry-related charges may add to the effect of spectral binding.

History

The solutions of the wave equation are known for more than two and a half centuries [1]. In those times physicists where not aware of the quantization of space, but some awareness was growing about the quantization of wave packages. The shock fronts are not waves. They do not feature a frequency. Wave packages disperse when they move. Shock fronts do not disperse. It is strange that during the development of quantum physics the shock fronts escaped the attention of the early quantum physicists. Otherwise, quantum field theory would have become a straight forward part of quantum theory.

Mathematics

Partial quaternionic differential equations that apply the quaternionic nabla ∇ describe the interaction between a field and a point-like artifact [2].

$\nabla \equiv \{\partial/\partial\tau, \partial/\partial x, \partial/\partial y, \partial/\partial z\}$

$\boldsymbol{\nabla} \equiv \{\partial/\partial x, \partial/\partial y, \partial/\partial z\}$

$\nabla_r \equiv \partial/\partial\tau$

τ is progression or proper time.

In the quaternionic differential calculus, differentiation with the quaternionic nabla is a quaternionic multiplication operation:

$$c = c_r + \mathbf{c} = ab \equiv (a_r + \mathbf{a})(b_r + \mathbf{b}) = a_r b_r - \langle\mathbf{a},\mathbf{b}\rangle + \mathbf{a} b_r + a_r \mathbf{b} \pm \mathbf{a}\times\mathbf{b}$$

Here the real part gets subscript $_r$ and the imaginary part is written in bold face.

The right side covers five different terms.
$\langle\mathbf{a},\mathbf{b}\rangle$ is the inner product.
$\mathbf{a}\times\mathbf{b}$ is the external product.

$\pm$ indicates the choice between right and left handedness.
Now the partial differential equation that describes the first order behavior of a continuum is given by:

$$\Phi = \phi_r + \boldsymbol{\Phi} = \nabla\psi \equiv (\nabla_r + \boldsymbol{\nabla})(\psi_r + \boldsymbol{\psi}) = \nabla_r\psi_r - \langle\boldsymbol{\nabla}, \boldsymbol{\psi}\rangle + \boldsymbol{\nabla}\psi_r + \nabla_r\boldsymbol{\psi} \pm \boldsymbol{\nabla}\times\boldsymbol{\psi}$$

$$\phi_r = \nabla_r\psi_r - \langle\boldsymbol{\nabla}, \boldsymbol{\psi}\rangle$$

$$\boldsymbol{\Phi} = \boldsymbol{\nabla}\psi_r + \nabla_r\boldsymbol{\psi} \pm \boldsymbol{\nabla}\times\boldsymbol{\psi}$$

$\langle\boldsymbol{\nabla}, \boldsymbol{\psi}\rangle$ is the divergence of $\boldsymbol{\psi}$

$\boldsymbol{\nabla}\psi_r$ is the gradient of ψ_r

$\boldsymbol{\nabla}\times\boldsymbol{\psi}$ is the curl of $\boldsymbol{\psi}$

$$\mathbf{E} = -\boldsymbol{\nabla}\psi_r - \nabla_r\boldsymbol{\psi}$$

$$\mathbf{B} = \boldsymbol{\nabla}\times\boldsymbol{\psi}$$

Double differentiation leads to the second order partial differential equation:

$$\rho = \nabla^*\phi = (\nabla_r - \boldsymbol{\nabla})(\nabla_r + \boldsymbol{\nabla})(\psi_r + \boldsymbol{\psi}) = (\nabla_r\nabla_r + \langle\boldsymbol{\nabla}, \boldsymbol{\nabla}\rangle)(\psi_r + \boldsymbol{\psi}) = \rho_r + \mathbf{J}$$

This equation splits into two first order partial differential equations $\Phi = \nabla\psi$ and $\rho = \nabla^*\phi$.

$$\rho_r = \langle\boldsymbol{\nabla}, \mathbf{E}\rangle$$

$$\mathbf{J} = \boldsymbol{\nabla}\times\mathbf{B} - \nabla_r\mathbf{E}$$

$$\nabla_r\mathbf{B} = -\boldsymbol{\nabla}\times\mathbf{E}$$

Two quite similar second order partial differential operators exist. The first is described above.

$$(\nabla_r\nabla_r + \langle\boldsymbol{\nabla}, \boldsymbol{\nabla}\rangle)\,\psi = \rho$$

This is still a nameless equation.

The second is the quaternionic equivalent of d'Alembert's operator $(\nabla_r\nabla_r - \langle\boldsymbol{\nabla}, \boldsymbol{\nabla}\rangle)$. It defines the quaternionic equivalent of the well-known wave equation.

$$(\nabla_r\nabla_r - \langle\boldsymbol{\nabla}, \boldsymbol{\nabla}\rangle)\,\psi = \varphi$$

Both second order partial differential operators are Hermitian differential operators.

Solutions

Waves

$$f(\tau, \mathbf{x}) = a \exp(i\,\omega(c\tau - |\mathbf{x} - \mathbf{x}'|));\ c = \pm 1$$

solves $\nabla_r\nabla_r f = \langle\boldsymbol{\nabla}, \boldsymbol{\nabla}\rangle f = -\omega^2 f$

Warps

ψ =g(x **i**±τ)

Clamps

ψ =g(r **i**±τ)/r

References

[1] https://en.wikipedia.org/wiki/Wave_equation#General_solution

[2] https://en.wikiversity.org/wiki/Hilbert_Book_Model_Project/Quaternionic_Field_Equations