

Quite a series of remarkable things happen in quantum theory.

Wave functions and characteristic vectors.

The first thing that draws attention is the concept of the wave function. It is a probability amplitude function that is correlated with an observable. On its turn the observable corresponds to a continuous normal operator. The wave function corresponds with a single vector in Hilbert space and its values correspond to the inner product of this vector with the eigenvectors of the operator that belongs to the observable. The corresponding eigenvalues form the argument of the wave function. The function describes the probability of finding a given eigenvalue when a suitable measurement of the observable is performed. It is a kind of shadow image taken with long exposure of the internal movements of the observed item. For very small objects like atoms these movements are harmonic and repeat themselves after a certain period. The harmonic movements correspond to eigenfunctions of a different operator. In simple cases it can be shown that these eigenfunctions are eigenfunctions of Fourier transforms. It is possible to choose different observables as the base of a wave function. One choice is the position observable. Another choice is the momentum observable. Still other choices are the spin and the angular momentum. With each of these choices corresponds a different probability density vector. Each of these vectors characterizes an aspect of the observed object. None of these vectors offers a full representation of the object.

According to the congruencies between quantum physics, quantum logic and the set of closed subspaces of a Hilbert space, a full representation of a physical object can only be given by a closed subspace of a Hilbert space. Since the vectors that correspond to different wave functions already differ, the subspace that represents the physical object will in general be multidimensional. With other words, it is false to interpret a wave function as a representative of a physical object.

On the one hand the quantum physical item corresponds to a hierarchy of propositions about a physical item. On the other hand the top of the hierarchy of these propositions corresponds to a closed subspace of the Hilbert space. In general that is not a ray. It is not spanned by a single vector, but by a bunch of mutually independent vectors. Each of these mutually independent constituting vectors corresponds to an atomic proposition. Each of these constituting vectors can carry at least one property. This property is also an eigenvalue of a (normal) operator. Vectors that are linear combinations of the mutually independent constituting vectors may be eigenvector of other normal operators. Such an operator may also own a set of eigenvectors that together span the same subspace. In this way the subspace can support quite a series of properties that all belong to the considered physical item.

It is interesting to consider observables that are each other's canonical conjugate. Here the Heisenberg uncertainty relation plays its part. It already specifies a certain minimal area in phase space. This corresponds with a minimal dimensionality of the presentation of a physical item that is higher than unity.

The wave function can be considered as a characteristic of a physical item. Another type of characteristic vector is used to indicate the precise location of a physical item in Hilbert space. A physical item possesses a series of different characteristic vectors. A characteristic vector can never on its own be considered as a full representation of a physical item. Further a characteristic vector cannot be interpreted as an eigenvector of all operators that act on the item's representation.

Static structure and dynamics

Two important aspects of quantum physics are its static structure and its dynamics. The static structure is mainly set by its fundament on traditional quantum logic. For another part it is ruled by the Helmholtz decomposition theorem. Traditional quantum logic does not state anything about dynamics. It also does not state anything about influences that exist between propositions. These influences correspond to vector fields. The static decomposition of vector fields is treated by the Helmholtz decomposition theorem. (More precisely, a Hodge decomposition suits better.)

Dynamics is correlated with the movement of the representations of physical items in Hilbert space. Unitary operators are usually considered as the actors that are capable of moving things around in Hilbert space. I will explain that this is a far too simple and in fact false interpretation of what is really happening.

Let us first look at the operators that act in Hilbert space. There exist two pictures in quantum physics. In the first picture, the Heisenberg picture, the representation of the considered item is moved through Hilbert space. In this picture the eigenvectors of operators that represent observables stay fixed. The subspace representing the item moves over the forest of eigenvectors of operators that are selected as observables. In this way it dynamically meets eigenvalues of these operators that become its properties. It looks as if the definition of the subspace in terms of eigenvectors of operators becomes a dynamic function of the progression parameter t . In the second picture, the Schrödinger picture, the eigenvectors of the operators that represent observables move over the subspace that represents the considered item. It looks as if the operators become a dynamic function of the progression parameter. For the experience of the considered item it does not matter which of the two pictures governs its dynamics.

However, these pictures are far too simplistic. Nature does not behave that way. Our observed space is curved. Further, its structure differs from the structure of the eigenspaces of the operators. Observed spacetime has a Lorentzian metric. Even when hyper complex numbers are used to define Hilbert spaces, the eigenspaces are Euclidean. Thus physicists must have played another trick. They use the results of differential geometry. However, curves and manifolds are not number fields or parts of number fields. Still, geodesic curves come very close to physics and geodesic equations have a great resemblance with equations of motions. But are the two things the same? Can you connect a moving subspace with a geodesic? Well if you restrict to one of its characteristic vectors you could. However, the move of the subspace occurs in Hilbert space and that space is not curved. The situation can only be explained when there exists something in Hilbert space that is curved.

The curved subject is not constituted from the eigenvectors or eigenvalues of normal operators. These subjects are properly evenly distributed. There must be something else in Hilbert space and it must also be represented in both quantum logic and in quantum physics. The answer to this question is formed by fields. They are represented in quantum logic by influences between propositions. In

quantum physics they are represented by physical fields. In Hilbert space the fields get a place in the arguments of the transformations that may push subspaces around.

A unitary transformation cannot push a subspace around in Hilbert space. It is a far too simple mathematical tool for that purpose. However, the thing that can do it can be simulated by a trail of infinitesimal unitary transformations. Let us give that thing a name. Let us call it a **redefiner**. It redefines subspaces in terms of eigenvectors of linear operators. You cannot do realistic quantum physics without such a redefiner! The elements of the trail all differ from each other. They have different sets of eigenvectors. Otherwise the subspace cannot move. The reason is that a unitary transform cannot move its own eigenvectors. Thus, the redefiner moves its own eigenfunctions and it does not move other vectors. Further, the elements of the trail are only used locally. It means that these elements may be taken to be much more exotic subjects than just infinitesimal unitary transforms. They only need to act locally like infinitesimal unitary transforms. They might even accept higher dimensional hyper complex numbers as their local eigenvalue. For example the 2^n -ons of Warren Smith act locally as 2^m -ons in their lower 2^m dimensions.

Why would you want higher dimensional eigenvalues? Well, they can store more properties! An 2^n -dimensional 2^n -on eigenvalue has place for 2^n real values. Isn't that nice? The moving (≥ 3 -dimensional) Frenet-Serre frame of a geodesic curve may be interpreted as the axes of a local hyper complex number field. That is a nice visualization of what is really happening.

The conclusion of the above analysis is that the plain use of unitary transforms in quantum physics must be reconsidered!

When you enter hyper complex Hilbert space you will encounter other features about which you never might have heard about. Hyper complex numbers perform transforms of their own. One very important number transform is the number waltz. In its simplest form it looks like: $c=a \cdot b/a$. With real or complex numbers this always results in $c=b$. However, with hyper complex numbers that have dimension greater than two the manipulated subject b may get a turn. Not its real part. That part is not touched. The imaginary part of b gets a partial precession. When a unitary transform acts on an operator that represents an observable then the effect of the number waltz can easily get larger than the effect of the transfer of the eigenvector of the observable. Elsewhere it is shown that in this way the number waltz can form the reason of existence of special relativity. Thus, there is reason to take the number waltz serious!

The number waltz may play a crucial role in the dynamics of quantum physics! If the given reason of existence of special relativity is correct, then physical dynamics cannot be understood properly without considering the influence of the number waltz. The number waltz, together with a particular choice of time step, introduces the Minkowski signature that forms the base of special relativity. Further the number waltz causes a clear split in quantum physics. It splits the manipulating part from the manipulated part. The game of the manipulating part takes place in Hilbert space. The game of the manipulated part takes place in a curved space that is characterized with a Minkowski signature and a Lorentzian metric.

Reason for a universe wide progression parameter

Unitary transforms are (continuous) normal operators and as such they possess an orthonormal set of eigenvectors that span the Hilbert space. The Hilbert space contains all subspaces that together represent the universe of all physical items. Thus, every unitary transformation, even the infinitesimal transformations that form elements of the trail that constitutes the redefiner, touches all items in universe. I consider this as a scaring idea, but it still might be right. It will mean that the redefiner has a universe wide scope. Each redefinition step will work universe wide. It means that the universe has a global clock. Before the redefiner takes a step the current status of the universe is governed by static laws such as quantum logic and the Helmholtz decomposition theorem. After taking the step these laws hold again but with different conditions. The step is a transfer from one static condition into another. Quantum logic rules how propositions about physical items relate to each other. The step rules how these propositions change. This change is NOT covered by quantum logic. The change of the propositions corresponds to a change of the subspaces of the Hilbert space that represent these propositions. The Helmholtz decomposition theorem states how vector fields can be split into a rotational and an irrotational part. The step rules how this partition changes. The change of the fields correlates to a change of the subspaces. In a static situation the fields compensate each other's activity. A non-compensated activity results in a move of a subspace. That move is done during a step. The action of the fields is represented in the argument of the redefiner. The current infinitesimal unitary transform performs the step. As a reaction to the action the repositioned subspaces cause a reconfiguration of the fields. This mechanism governs the dynamics of quantum physics. It controls both the kinematics of the physical items as well as the dynamics of the fields. The Maxwell equations show how the electromagnetic fields changes. Other fields such as the gravitation field react similarly. Dennis Sciama gave an elucidating explanation of these effects in his "Origin of inertia".

It is interesting to note that the Helmholtz decomposition theorem is directly related to the fact that the Fourier transform of the vector field can be split into a longitudinal part and a transversal part. This again relates to the fact that the multidimensional Dirac delta function can be split into a longitudinal part and a transversal part. Thus, between steps these splits are reestablished as new status quos.

Origins of dynamics

Quantum physics has many aspects. Each of these aspects has its own origin of dynamics. These aspects have representations in four areas. The first area is nature. The second area is quantum physics. The third area is quantum logic and the fourth area is Hilbert space.

For macroscopic movements the origin of dynamics can be found in the interaction between fields and the items that are subject of their actions.

In nature fields cannot be sensed directly. They can only be noticed indirectly by their effect on items that exist in nature. In quantum physics fields have their own section of science in the form of quantum field theory. The fields influence physical items such as elementary particles and galaxies. Sometimes the interaction is very intense and the elementary items behave like waves of fields.

In Hilbert space the fields have their place in the arguments of unitary operators. As stated above the operators are only used in their infinitesimal format. This restriction holds both in spatial as well as in “temporal=progressive” sense. The infinitesimal unitary operators act on closed subspaces. The fields are raised by physical items, which correspond to closed subspaces and to a certain kind of propositions. They act on other physical items/closed subspaces/propositions.

In quantum logic the fields correspond to influences between propositions. They depend on how the proposition is redefined and they depend on the distance between the actuator and the influenced subject. In quantum logic, both are propositions. The redefinition concerns the way the enveloping proposition is constituted from atomic propositions. The distance in quantum logic corresponds to the distance in Hilbert space between characteristic vectors of the corresponding subspaces. These characteristic vectors must be of a suitable type.

Apart from macroscopic movements there consist movements that occur inside physical items. Usually these movements are periodic. In well-formed physical items these movements are harmonic. Harmonic movements are directly related with eigenvectors of special operators. These operators have a discrete or mixed spectrum of eigenvalues. This indicates that internal movements are governed by processes that differ significantly from processes that govern macroscopic movements.

The internal movements give rise to a next kind of dynamical behavior. That behavior concerns the creation and annihilation of items. These effects usually go together with a change of eigenvalue (property) of a related item that emits or absorbs the other item.

So far we can see the following types of quantum physics (QP):

- The stationary QP (Quantum logic; Helmholtz decomposition theorem)
- The QP of the fields/influences (Quantum field theory)
- The QP of the manipulators (redefiniers)
- The QP of the numbers (number waltz)
- The macroscopic dynamic QP (operator driven / number driven)
- The internal dynamic QP
- The creation/annihilation QP

Only the number driven macroscopic dynamic QP is governed by a Minkowski signature and must cope with a maximum speed of information transfer.

More details can be found in <http://www.scitech.nl/English/Science/Exampleproposition.pdf> .

Appendix: The effect of the number waltz

Manipulation

The redefiner R_t can be mimicked by a trail of infinitesimal unitary transforms. Each subsequent trail element has eigenvectors that differ from those of its predecessor. These eigenvectors are also eigenvectors of R_t . For a single vector, which is not an eigenvector of R_t , the action of R_t can be represented by the integrated activity of this trail on that vector. This can be interpreted as the activity of a genuine unitary transform U_t . When a redefiner R_t is applied to the eigenvector $|q\rangle$ of an operator Q with eigenvalue q , then the eigenvector is transferred into another vector $|U_t q\rangle$. The expectation value for $|QU_t q\rangle$ is no longer q , but

$$\langle q | U_t | QU_t q \rangle = \langle q | U_t^\dagger Q U_t q \rangle \approx u_t^* q u_t,$$

where u_t is the expectation value $\langle q | U_t q \rangle$ of U_t for vector $|q\rangle$. With real and complex numbers this just equals q , but for higher 2^n -ons q can be affected by this number transformation. This number transformation is the number waltz. It causes a partial precession of the imaginary part of q and does not affect the real part of q . The effect depends on the argument of u . When the action of U_t proceeds further in a stationary way, then it causes a full precession of q . That is why the transformation $u_t^* q u_t$ gets the name number waltz.

All observations that go together with a redefinition are affected by the described number waltz.

However, in some cases the number waltz has no effect. This occurs when the action of u_t is parallel to the imaginary part of q .

Relativity

The trail that is taken by the actions of the redefiner can be studied with the toolkit of differential geometry. The study of inertia shows that geodesics traveled with uniform speed are not affected by inertia. Therefore we take the steps such that the action curve features unit speed and becomes a geodesic. Let us consider the action of an infinitesimal unitary transform. First we assume that the displacement of the eigenvector $|q\rangle$ of operator Q due to the action of the infinitesimal unitary transform has only a minor effect on the change of the eigenvalue q .

The tantrix e_0 of that curve delivers the main part of the action S . The eigenvalue u of the redefiner can be specified as a function of the trail progression parameter t . The Taylor expansion gives:

$$u_{t+\Delta t} = u_t \cdot (1 + \Delta s_t)$$

$$\Delta s_t = e_{t0} \cdot \Delta t + e_{t1} \cdot (\Delta t)^2 \cdot \chi_{t1} / 2 + e_{t2} \cdot (\Delta t)^3 \cdot \chi_{t1} \cdot \chi_{t2} / 6 + \mathcal{O}((\Delta t)^3)$$

$$u_t = \prod (1 + \Delta s_\tau), \tau = 0 \dots t$$

$$\Delta u_t \approx u_t \cdot \Delta s_t$$

Thus all trail elements are close to unity. The expansion also holds when u_t is a higher dimensional 2^n -on. Since 2^n -ons for $n > 1$ don't commute, the ordering of the products is important. ΔS_{rt} and ΔS_{lt} differ. The tantrix e_{t0} is in general not imaginary. The imaginary part of this tantrix is the direct cause of the waltz of the observations, but the real part also influences the amount of rotation that the number waltz causes. The result of the action step is:

$$q_t = u_t^{-1} \cdot q \cdot u_t \approx (1 - \Delta s_{rt}) \cdot u_{t0} \cdot q_{t0} \cdot u_{t0} \cdot (1 + \Delta s_{rt})$$

The real part of q is not affected. So, we only consider the imaginary part.

$$\underline{q}_t \approx (1 - \Delta s_{rt}) \cdot \underline{q}_{t0} \cdot (1 + \Delta s_{rt})$$

$$\Delta \underline{q}_t \approx \underline{q}_{t0} \cdot \Delta s_{rt} - \Delta s_{rt} \cdot \underline{q}_{t0} - \Delta s_t \cdot \underline{q}_{t0} \cdot \Delta s_{rt} \approx 2 \cdot \underline{q}_{t0} \times \Delta s_{rt} \quad (1)$$

Thus the **space step** $\Delta \underline{q}_t$ is perpendicular to both \underline{q}_{t0} and $\Delta \underline{s}_{rt0}$. Let us define the local **spacetime step** $\Delta \underline{\sigma}_t$ as the action step Δs_{rt} .

$$\Delta \underline{\sigma}_t := \Delta s_{rt} \approx \underline{e}_{0rt} \cdot \Delta t$$

Due to the action of the number waltz, the **space** step occurs perpendicular to the spacetime step. The rectangular triangle can be closed with a step that we will relate to the **coordinate time** interval $\Delta \underline{\tau}_t$.

$$\Delta \underline{\tau}_t := \Delta \underline{q}_t / c + \underline{e}_{0rt} \cdot \Delta t$$

In this setting the factor $2 \cdot \underline{q}_{t0}$ is ignored. \underline{e}_{0rt} is a unit size vector. The formula that relates the three steps corresponds to a time-like convention:

$$|\Delta t|^2 = |\Delta \tau|^2 - |\Delta q|^2 / c^2$$

The steps define a **Minkowski** metric and as a consequence it raises **special relativity**. The curvature of the manipulator trail causes an additional curvature of the trail of the observed position. The corresponding manifold is not Riemannian, but pseudo-Riemannian. More precisely, it is Lorentzian. The action in the argument of the current manipulator can be related to the combined influences of fields. The curvature in action space brings general relativity into the picture.

Coordinate time has only local significance. It only exists in combination with an observation of position in Q space. The combination of coordinate time and Q space no longer corresponds to quaternions. These specimens are better treated with Clifford algebras. In this way the quaternion waltz introduces other algebras than 2^n -ons.

- In the above procedure we ignored the relation (1).
- We only looked at the dynamic steps.
- We introduced a new progression concept: the coordinate time.
- With these measures we introduced a maximum speed of information transfer c .

Division

The number waltz causes a separation between two very different worlds. The manipulators play their dynamic game in Hilbert space with progression parameter t , which comes close to proper time. They are not affected by a maximum speed c . The manipulated subjects live in the observed space, which has a Minkowski/Lorentzian metric and a quite different progression parameter τ , which we call coordinate time.

