Underneath the wave function

What exists underneath the wave function?

Abstract

Nearly all tools that quantum physicists use are in some way based on the concept of the wave function. This means that such tools deliver a blurred view of the fine grain structures and fine grain behavior that these tools describe. This appears no handicap for applied physics. The tools fill the complete need of applied quantum physics. However, the blurred view hampers the search for the origins of features and phenomena, because they must be sought in the fine grain structure and the fine grain behavior.

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Contents

Tools

Many of the tools that quantum physicist use are directly or indirectly based on the information that is contained in the wave function. Also the equations that the corresponding quantum physics applies reflect what happens with this information. The wave function is a differentiable normalized continuous function and it owns a Fourier transformed version. It is commonly characterized as a probability amplitude distribution. Its squared modulus is a probability density distribution.

These characteristics make the wave function accessible to a large mathematical toolkit. Most of these tools base on Lie groups and Lie algebras.

The wave function

What is the wave function?

Let us focus onto the wave function in configuration space.

It is a probability amplitude distribution.

Its squared modulus is a probability density distribution.

That probability density distribution is a normalized continuous location density distribution.

Interpretation

Now interpret what this probability density distribution may stand for.

1. It is the probability of detecting the owner of the wave function at the location that is defined by the parameter of the wave function.
2. It is a continuous location density distribution
    a. That continuous location density distribution is the continuous description of a discrete location density distribution.
    b. This density distribution describes locations where the owner of the wave function can be.
    c. One of these locations is the currently actual location.

Now see the second interpretation as a dynamic process.

At each subsequent instance the owner uses a new location.

The locations form a coherent swarm and at the same time the locations form a path.

The owner hops along that path.

If the owner is actually detected, then the hopping stops. The path and the swarm are no longer developed further. With other words, ***the wave function collapses***. Usually the owner does not disappear. It is transformed into something else that also has a wave function. This means that at the instance of detection a new wave function is generated that characterizes the transformed object. It is also possible that the owner disintegrates into multiple objects. In any of these cases the original wave function loses its significance.

It is sensible to conclude that underneath the wave function some ***fine grain structure*** exists and that ***fine grain dynamics*** may occur.

Who has ever thought that a stochastic path may exist underneath the blurred description that the wave function represents?

The idea of the swarm and the stochastic micro-path can be exploited further. This opens a completely new and fresh view on the lowest levels of physics and what elementary particles could be. In the above sketched view they are ***point particles*** that have ***no internals***, but instead they have ***externals***. These externals are formed by the swarm that includes a micro-path. Most of the elements of the swarm are virtual locations that can be interpreted as past or future locations. Only one element represents the current location. However, the duration of that location is set by a very short progression step.

In a Hilbert space the elements of the swarm can be represented as eigenvalues of an operator. The eigenvalues of Hilbert spaces can be real numbers, complex numbers or quaternions. When a quaternionic Hilbert space is used, then these eigenvalues can cover progression and a 3D location. The corresponding eigenvectors span a subspace of the Hilbert space. With other words the swarm is represented by a subspace of the Hilbert space. ***All discrete objects that own a wave function are represented by a subspace of the Hilbert space***.

The closed subspace that is spanned by the location eigenvectors is ***eigensubspace*** of another operator whose eigenvalues are retrieved from the full set of location eigenvalues that correspond to the swarm. For example the symmetry of the set and the characteristics of the micro-path lead to swarm wide properties. At any progression instant the state of the swarm is represented by the current location and by the extra properties that are delivered by the swarm wide operator.

Gelfand triple

When we want to go back from the swarm to the wave function, then we must make use of the Gelfand triple. Every Hilbert space owns a Gelfand triple. The Gelfand triple features operators that have continuum eigenspaces. In the Gelfand triple operators exists that corresponds to the swarm-element-location operator and the swarm-wide operator in the Hilbert space. Part of the continuum eigenspace of the swarm element-location operator will represent the wave function.

Something is missing here. That is the parameter space of the wave function. This is delivered by another operator that also resides in the Gelfand triple. Its eigenspace is flat and is spanned by the quaternions. An equivalent of this parameter operator exists in the Hilbert space. Its eigenspace is spanned by the rational quaternions. These two operators represent a precise fit between the Hilbert space and its Gelfand triple. For other operator pairs the fit might be imprecise.

The wave function can be mapped back into Hilbert space, but this time the equivalent of the Gelfand triple parameter space operator is used as parameter space. The corresponding eigenvectors will now carry density values. Thus the map of the wave function back into the Hilbert space delivers a density operator. That density operator is derived from the wave function and as a consequence it still delivers a blurred view on the fine grain structure of the swarm and a blurred view of the fine grain dynamics of the elements of the swarm. For example the stochastic micro-path cannot be uncovered from the density operator.

Tools

This is typical for most tools that physicists apply. They blur fine grain structures and fine grain behavior.

On the other hand the continuous descriptors can use the full toolkit that Lie groups and Lie algebras offer. This leads to the usual equations of motion that quantum physics applies.

What are the equations for the fine grain behavior of the elements of the swarm?

The blurred tools fit the needs of applied quantum physics. They hide fine grain structure, but who cares? Only those that are interested in the origin of the phenomena and structure features might care. However, the blur easily leads to false interpretations of what really happens below the wave function. As long as these false interpretations do not harm applications, this defect of the methodology does not matter.

Only people with enough free time (like me) can invest the resources in order to find out what exists down there.

Dynamical coherence

The control of dynamical coherence has to do with the fit between the Hilbert space and the Gelfand triple. A perfect fit kills all dynamics. No control causes dynamical chaos. Ruled control is detectable (and is not yet detected). Stochastic based control fits to the stochastic nature of the wave function.

Generating the wave function

Take a particle

Embed it at a given location in a continuum.

At the next instance embed it at a slightly different location

This new location is NOT KNOWN IN ADVANCE.

Keep selecting new locations.

After a while the set of locations looks like a swarm.

The stochastic characteristics of the process are constant.

Thus after a while the continuous location density distribution that describes the swarm no longer changes in a noticeable way.

The normalized version of this continuous function is a probability density distribution.

It is the squared modulus of the wave function.

It is not self-evident that the density function is a continuous function and it is also not self-evident that this function can be normalized and that it owns a Fourier transform. Some mechanism must ensure these non-self-evident facts.

The probability density distribution has a Fourier transform. (Because the wave function has a Fourier transform.

As a consequence the swarm owns a displacement generator.

Thus at first approximation the swarm moves as one unit.

Further the probability density distribution is a wave package.

Multiple versions of the same type of particle can together form detection patterns that look like interference patterns.

This can be interpreted as wave behavior.

Preparation in advance

It looks as if the swarm is prepared in advance.

At every progression instant only one of the elements of the prepared swarm is randomly selected in order to become the ACTUAL location of the particle.

This situation only lasts during a single progression step.

After a while the whole planned swarm is used. At that instance a new swarm is prepared.

It is also possible that the swarm generation is an on-going process.

If swarms are prepared in advance, then different types of swarms can be prepared in seclusion.

These types may have different symmetries!

Three dimensional swarms may exist in 2^3=8 different symmetries..

Thus swarms may exist in at least 8 types.

Also continuous quaternionic functions exist in bundles that only vary in their symmetries.

Thus the quaternionic representation of the wave functions may exist in that many symmetry flavors.

The embedding continuum shows many aspects of a field and that field can be represented by a mostly continuous quaternionic function.

That function is not continuous at the location of the embedding of a particle.

However, due to the quick regeneration at a slightly different location, the singularities are effectively smoothened.

Thus in an averaged view the embedding continuum can be considered to be a continuous function. The particles exist in 8 symmetry flavors and embedding continuums also exist in 8 symmetry flavors. As a consequence, embedding can offer 8x8 coupling versions.

Eigensubspaces

The elements of the swarm are represented by eigenvectors. These eigenvectors span a closed subspace. The swarm has extra properties that are set by the discrete symmetries of the swarm. In this way the subspace and the extra properties form eigensubspaces of a corresponding operator. This operator has an equivalent in the Gelfand triple.

Since the eigenvalue sets exist in 8 symmetry flavors, will eigensubspaces exist in 8 varieties. Embedding continuums also occur in 8 symmetry flavors. The coupling between the eigensubspaces and the embedding continuums exist in $8\times8=64$ varieties. Electric charge, color charge and spin partly characterize these coupling varieties.

Reference symmetry flavor

For continuous quaternionic functions it has sense to assign a reference symmetry flavor. It is the reference flavor of the parameter space. Coupling of a swarm to an embedding continuum that has the reference symmetry flavor produces a special category of particles. That category contains eight types. In contemporary physics this category contains the fermions.

Stochastic grain

Why is the wave function a probability amplitude distribution?

The swarm that is introduced above may be generated by a combination of a Poisson process and a binomial process. The binomial process is implemented by a three dimensional spread function. The Poisson process delivers the parameter for the spread function. The result is something that is close to a Gaussian location distribution (a 3D normal distribution).

When seen as a charge distribution rather than as a location distribution, then the swarm corresponds to a rather smooth potential that at short distance looks as Erf(r)/r and at somewhat greater distance as 1/r. Thus it contains NO SINGULARITY!

Movement

For a frame that moves with the swarm, the swarm is at rest. If the swarm moves with respect to a frame , then the swarm and the micro-path are stretched along the movement path. ***If the hop size does not change***, then with a fast uniform movement in a flat embedding continuum the micro-path is unfolded into a chain that is parallel to a straight line. Under these conditions the swarm cannot go faster. Thus if hops already occur with maximum speed then a maximum speed for the swarm exists.

If all swarms have a fixed number of elements and the average hop size is a general constant then the maximum speed of swarms is a general constant.

Summary

These deliberations show that it has sense to reason about what exists underneath the wave function.

This paper gives insight in what may exist underneath the wave function. Here an example is given and it need not be the correct view. That correct view is not the intention of the paper. The intention is to show that it is not smart to deny the existence of features and phenomena that might exist underneath the wave function. Quite probably these features and phenomena will never be directly observable. However, their traces in the form of their averaged or smoothed effects are noticeable. Contemporary physics uses these smoothed and averaged data in order to design applications.

If you want to understand the foundations of physics, then you must dive into the wonderland that exists underneath the wave function. The wave function does not explain these foundations. It only describes what happens to wave functions.