QUANTUM STRING FIELD THEORY AND PSYCHOPHYSICS

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The quantum string field theoretic structure of interactive phenomena is discussed.

This note continues the author’s researches on the boundary of experimental mathematics, psychophysics and computer science, which were initiated about ten years ago. Precisely, it is devoted to the unraveling of quantum string field theoretic (general aspects of this theory are discussed in the book [1] and its mathematical formalism based on the infinite dimensional geometry is exposed in [2]) structures in the picture described in two previous notes [3]. The results may be significant for the constructing of a very important bridge between fundamental theoretical high-energy physics and modern psychophysics. The interactive game theoretic surrounding of the least may essentially enrich the quantum string field theory by new original features, which will be interesting for pure mathematicians. Such alliance may be interesting to the theoretical physicists as supplying their sophisticated constructions with a very simple and inexpensive experimental verification.

I. Interactive phenomena: experimental detection and analysis [3]

1.1. Experimental detection of interactive phenomena. Let us consider a natural, behavioral, social or economical system $S$. It will be described by a set $\{\varphi\}$ of quantities, which characterize it at any moment of time $t$ (so that $\varphi = \varphi_t$). One may suppose that the evolution of the system is described by a differential equation

$$\dot{\varphi} = \Phi(\varphi)$$

and look for the explicit form of the function $\Phi$ from the experimental data on the system $S$. However, the function $\Phi$ may depend on time, it means that there are some hidden parameters, which control the system $S$ and its evolution is of the form

$$\dot{\varphi} = \Phi(\varphi, u),$$

where $u$ are such parameters of unknown nature. One may suspect that such parameters are chosen in a way to minimize some goal function $K$, which may be an integrodifferential functional of $\varphi_t$:

$$K = K([\varphi_\tau]_{\tau \leq t})$$
(such integrodifferential dependence will be briefly noted as $K = K([\varphi])$ below). More generally, the parameters $u$ may be divided on parts $u = (u_1, \ldots, u_n)$ and each part $u_i$ has its own goal function $K_i$. However, this hypothesis may be confirmed by the experiment very rarely. In the most cases the choice of parameters $u$ will seem accidental or even random. Nevertheless, one may suspect that the controls $u_i$ are interactive, it means that they are the couplings of the pure controls $u_i^0$ with the unknown or incompletely known feedbacks:

$$u_i = u_i(u_i^0, [\varphi])$$

and each pure control has its own goal function $K_i$. Thus, it is suspected that the system $S$ realizes an interactive game. There are several ways to define the pure controls $u_i^0$. One of them is the integrodifferential filtration of the controls $u_i^0$:

$$u_i^0 = F_i([u_i], [\varphi]).$$

To verify the formulated hypothesis and to find the explicit form of the convenient filtrations $F_i$ and goal functions $K_i$ one should use the theory of interactive games, which supplies us by the predictions of the game, and compare the predictions with the real history of the game for any considered $F_i$ and $K_i$ and choose such filtrations and goal functions, which describe the reality better. One may suspect that the dependence of $u_i$ on $\varphi$ is purely differential for simplicity or to introduce the so-called intention fields, which allow to consider any interactive game as differential. Moreover, one may suppose that

$$u_i = u_i(u_i^0, \varphi)$$

and apply the elaborated procedures of a posteriori analysis and predictions to the system.

In many cases this simple algorithm effectively unravels the hidden interactivity of a complex system. However, more sophisticated procedures exist [3].

Below we shall consider the complex systems $S$, which have been yet represented as the $n$-person interactive games by the procedure described above.

1.2. Functional analysis of interactive phenomena. To perform an analysis of the interactive control let us note that often for the $n$-person interactive game the interactive controls $u_i = u_i(u_i^0, [\varphi])$ may be represented in the form

$$u_i = u_i(u_i^0, [\varphi]; \varepsilon_i),$$

where the dependence of the interactive controls on the arguments $u_i^0$, $[\varphi]$ and $\varepsilon_i$ is known but the $\varepsilon$-parameters $\varepsilon_i$ are the unknown or incompletely known functions of $u_i^0$, $[\varphi]$. Such representation is very useful in the theory of interactive games and is called the $\varepsilon$-representation.

One may regard $\varepsilon$-parameters as new magnitudes, which characterize the system, and apply the algorithm of the unraveling of interactivity to them. Note that $\varepsilon$-parameters are of an existential nature depending as on the states $\varphi$ of the system $S$ as on the controls.

The $\varepsilon$-parameters are useful for the functional analysis of the interactive controls described below.
First of all, let us consider new integrodifferential filtrations $V_\alpha$:

$$v_\alpha^o = V_\alpha([\varepsilon],[\varphi]),$$

where $\varepsilon = (\varepsilon_1, \ldots, \varepsilon_n)$. Second, we shall suppose that the $\varepsilon$-parameters are expressed via the new controls $v_\alpha^o$, which will be called desires:

$$\varepsilon_i = \varepsilon(v_1^o, \ldots, v_m^o, [\varphi])$$

and the least have the goal functions $L_\alpha$. The procedure of unraveling of interactivity specifies as the filtrations $V_\alpha$ as the goal functions $L_\alpha$.

### 1.3. SD-transform and SD-pairs.

The interesting feature of the proposed description (which will be called the $S$-picture) of an interactive system $S$ is that it contains as the real (usually personal) subjects with the pure controls $u_i$ as the impersonal desires $v_\alpha$. The least are interpreted as certain perturbations of the first so the subjects act in the system by the interactive controls $u_i$ whereas the desires are hidden in their actions.

One is able to construct the dual picture (the $D$-picture), where the desires act in the system $S$ interactively and the pure controls of the real subjects are hidden in their actions. Precisely, the evolution of the system is governed by the equations

$$\dot{\phi} = \Phi(\varphi, v),$$

where $v = (v_1, \ldots, v_m)$ are the $\varepsilon$-represented interactive desires:

$$v_\alpha = v_\alpha(v_1^o, [\varphi]; \tilde{\varepsilon}_\alpha)$$

and the $\varepsilon$-parameters $\tilde{\varepsilon}$ are the unknown or incompletely known functions of the states $[\varphi]$ and the pure controls $u_i^o$.

D-picture is convenient for a description of systems $S$ with a variable number of acting persons. Addition of a new person does not make any influence on the evolution equations, a subsidiary term to the $\varepsilon$-parameters should be added only.

The transition from the S-picture to the D-picture is called the $SD$-transform. The $SD$-pair is defined by the evolution equations in the system $S$ of the form

$$\dot{\phi} = \Phi(\varphi, u) = \tilde{\Phi}(\varphi, v),$$

where $u = (u_1, \ldots, u_n)$, $v = (v_1, \ldots, v_m)$,

$$u_i = u_i(u_1^o, [\varphi]; \varepsilon_i)$$

$$v_\alpha = v_\alpha(v_1^o, [\varphi]; \tilde{\varepsilon}_\alpha)$$

and the $\varepsilon$-parameters $\varepsilon = (\varepsilon_1, \ldots, \varepsilon_n)$ and $\tilde{\varepsilon} = (\tilde{\varepsilon}_1, \ldots, \tilde{\varepsilon}_m)$ are the unknown or incompletely known functions of $[\varphi]$ and $v^o = (v_1^o, \ldots, v_m^o)$ or $u^o = (u_1^o, \ldots, u_n^o)$, respectively.

Note that the S-picture and the D-picture may be regarded as complementary in the N.Bohr sense. Both descriptions of the system $S$ can not be applied to it simultaneously during its analysis, however, they are compatible and the structure of SD-pair is a manifestation of their compatibility.
II. Quantum string field theoretic structure of interactive phenomena

2.1. The second quantization of desires. Intuitively it is reasonable to consider systems with a variable number of desires. It can be done via the second quantization.

To perform the second quantization of desires let us mention that they are defined as the integrodifferential functionals of $\varphi$ and $\varepsilon$ via the integrodifferential filtrations. So one is able to define the linear space $H$ of all filtrations (regarded as classical fields) and a submanifold $M$ of the dual $H^*$ so that $H$ is naturally identified with a subspace of the linear space $\mathcal{O}(M)$ of smooth functions on $M$. The quantized fields of desires are certain operators in the space $\mathcal{O}(M)$ (one is able to regard them as unbounded operators in its certain Hilbert completion). The creation/annihilation operators are constructed from the operators of multiplication on an element of $H \subset \mathcal{O}(M)$ and their conjugates.

To define the quantum dynamics one should separate the quick and slow time. Quick time is used to make a filtration and the dynamics is realized in slow time. Such dynamics may have a Hamiltonian form being governed by a quantum Hamiltonian, which is usually differential operator in $\mathcal{O}(M)$.

If $M$ coincides with the whole $H^*$ then the quadratic part of a Hamiltonian describes a propagator of the quantum desire whereas the highest terms correspond to the vertex structure of self-interaction of the quantum field. If the submanifold $M$ is nonlinear the extraction of propagators and interaction vertices is not straightforward.

2.2. Quantum string field theoretic structure of the second quantization of desires. First of all, let us mark that the functions $\varphi(\tau)$ and $\varepsilon(\tau)$ may be regarded formally as an open string. The target space is a product of the spaces of states and $\varepsilon$-parameters.

Second, let us consider a classical counterpart of the evolution of the integrodifferential filtration. It is natural to suspect that such evolution is local in time, i.e. filtrations do not enlarge their support (as a time interval) during their evolution. For instance, if the integradifferential filtration depends on the values of $\varphi(\tau)$, $\varepsilon(\tau)$ for $\tau \in [t_0 - t_1, t_0 - t_2]$ at the fixed moment $t_0$ it will depend on the same values for $\tau \in [t - t_1, t - t_2]$ at other moments $t > t_0$. This supposition provides the reparametrization invariance of the classical evolution. Hence, it is reasonable to think that the quantum evolution is also reparametrization invariant.

Reparametrization invariance allows to apply the quantum string field theoretic models to the second quantization of desires. For instance, one may use the string field actions constructed from the closed string vertices (note that the phase space for an open string coincides with the configuration space of a closed string) or string field theoretic nonperturbative actions. In the least case the theoretic presence of additional ”vacua” (minimums of the string field action) is very interesting.

2.3. Additional fields and virtual subjects. Often quantum string field theory claims an introduction of additional fields (such as bosonised ghosts). Let us consider such fields in the D-picture.

In D-picture desires have their own $\varepsilon$-parameters and depend on the pure controls of subjects. These pure controls may be obtained from the $\varepsilon$-parameters of desires via integrodifferential filtrations. One is able to apply such filtrations to the
additional fields. There are two possibilities. First, the result is expressed via the known pure controls. Second, the result is a new pure control of a virtual subject. Certainly, any experimental detection of virtual subjects is extremely interesting.

III. Conclusions

Thus, the quantum string field theoretic structure of interactive phenomena is described. Possible qualitative effects, which are produced by this structure and confirm its presence, are emphasized. Perspectives are briefly specified.

References

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