Caducity of Idea about Wave Function Collapse as well New Views on Schrödinger's Cat and Quantum Measurements

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Investigated idea was actuated by the old opinion that a measurement of a quantum observable should be regarded a as a single deterministic sampling. But, according to the last decades studies, such observables are veritable random variables and their measurements must imply significant sets of statistical samplings. So one finds the indubitable caducity of the approached idea. Contiguously the respective finding allows to put into a new light the controversial questions like the Schrödinger cat thought experiment or description of quantum measurements.

1 Introduction

A recent highly authorized opinion [1] points out the existing deadlock that: "*There is now ... no entirely satisfactory interpretation of Quantum Mechanics (QM)*". As major question of that deadlock is recognized as being [2] the problem of Quantum Measurements (QMS), in whose center still stands [3] the Idea about Wave Function Collapse (IWFC). For IWFC, demarcated as above, the most known debates and mainstream publications are reported in [1–3].

Here, in discussing the IWFC question, we try to present a somewhat "unconventional" strategy based on viewpoints promoted in our modest researches about QM, developed over last few decades (see [4, 5] and references).

Firstly we note the fact that, historically, IWFC emerged at the same time with the inaugural ideas regarding the Conventional Interpretation of Uncertainty Relations (CIUR). In the main CIUR started [4, 5] by mixing the theoretical representation (modeling) of a a physical quantity regarding a quantum state/system with a "*fictitious observation*" (done through some thought (gedanken) measuring experiment) of the respective quantity. The mentioned mixing invented and promoted the widespread term of "*observable*" for such a quantity. Below, similarly to the nowadays publications, we will use also the respective term.

After the alluded start CIUR coagulates in a form of an apparent doctrine centered on two main pieces:

(i) Heisenberg's thought-experimental formula and

(ii) Robertson- Schrödinger theoretical relation.

The respective doctrine can be incorporated [4,5] in few basic items (presumptions/ assertions). A deep analysis shows [4, 5] that the respective items, considered as single or grouped pieces, are incriminated by indubitable facts which are unsurmountable within the framework of CIUR. Then CIUR proves oneself to be deprived of necessary qualities for a valid scientific construction. Consequently, in spite of its apology in many modern texts (see references from [4]), CIUR must be abandoned as a wrong conception without any real value or scientific significance.

In its turn, IWFC continued to be present in important publications (see [1–3] and references), with explicit or implicit references to CIUR. It was aroused by the conflict between two items:

(i) The old opinion that a measurement of a quantum observable should be regarded a as a single deterministic sampling and

(ii) The agreement, enforced by theoretical practice, that studies of quantum systems use probabilistic (non-deterministic) entities (wave functions and observables/operators).

For avoiding conflict and breaking a deadlock it was devised the IWFC which, in different readings, was assumed in a large number of publications. But, as a rule, such assumptions were (and still are) not associated with adequate investigations regarding the truthfulness of the respective idea in relation with the QM questions. A modest investigation of that kind we will try to present below in the next sections.

Firstly, in Section 2, we point out the fact that in the main (i.e. irrespectively of its readings) IWFC is nothing but an useless fiction. Such a fact certainly shows the caducity and failure of the respective idea. In Section 3 we discuss the some aspects contiguous between failure of IWFC and famous subject of Schrödinger's cat thought experiment. Then within Section 4 we argue that alternatively to the IWFC we have to reconsider our views about QM theory in relation with QMS. So, for the readings of the respective theory, we must to consider either a restricted-QM (r-QM) or an extended-QM (e-QM) form. On the one hand the r-QM is essentially the version promoted by usual QM textbooks [6, 7] and it deals exclusively only with the modeling of intrinsic properties for the studied systems. On the other hand e-QM must to contain also obligatorily some additional elements regarding QMS descriptions (i.e. theoretical models about characteristics of measuring devices/procedures). Figuratively speaking e-QM consists in r-QM united with QMS descriptions. An simple exemplification of a QMS description, regarded in the mentioned sense, is presented in the end of the same Section 4. Finally, in Section 5, are given some concluding remarks about the views from this article.

2 Uselessness of IWFC

Now let us try to estimate the usefulness and truthfulness degrees of IWFC. Such an estimation can be obtained if IWFC is regarded through the details of its constituent elements. The before mentioned regard must be opened by observation that the starting purpose of IWFC was to harmonize the following two conflicting Items (***I***):

I$_1$ The old opinion (of the same time as CIUR) that a measurement of a quantum observable A, specific to a state/system at atomic scale, should be regarded as a single sampling which gives an unique deterministic result, say a_i;

I$_2$ The theoretical agreement that, due to the probabilistic character of wave function Ψ describing the alluded state/system, the observable A is endowed with a spectrum (set) of distinct values.

So came into an equivocal sight IWFC knew a lot of debates (see [1–3] and references). In essence, the solution promoted by the respective debates can be summarized within the following Subterfuge (***S***):

S The unique result a_i and wave function Ψ, mentioned in items ***I***$_1$ and ***I***$_2$, should be seen (and described) through the wave function collapse $\Psi \longmapsto \psi_i$, where Ψ depicts the considered quantum state/system in its wholeness while ψ_i is the a_i-eigenfunction of the operator $\widehat{A}$ (associated to the observable A) — i.e $\widehat{A}\psi_i = a_i\psi_i$.

For a proper judgment of such a subterfuge we have to reconsider the correctness of the items ***I***$_1$ and ***I***$_2$. In the light of such a reason it must to note that studies from the last decades (see [4–7] and references) consolidated beyond doubt the fact that, mathematically, a quantum observable A (through of the operator $\widehat{A}$) is a true random variable. In a theoretical viewpoint, for a given quantum state/system, such a variable is regarded as endowed with a spectra of values associated with corresponding probabilities (more exactly probability amplitudes). Then, from an experimental perspective, a measurement of a quantum observable requires an adequate number of samplings finished through a significant statistical group of data (outcomes).

Previous opinions about the randomness of quantum observables can be consolidated indirectly by mentioning the quantum-classical probabilistic similarity (see [4, 8]) among the respective observables and macroscopic variables studied within phenomenolgical (thermodynamic) theory of fluctuations [4, 9–14]. In this way let us refer to such a macroscopic random observable $\widehat{\mathbb{A}}$. Its intrinsic (*in*) characteristics are given in details by a continuous spectra of values $\mathcal{A}$ inside of spectra (range) Ω_{in} (i.e. $\mathcal{A} \in \Omega_{in}$), associated with a probability density $w_{in} = w_{in}(\mathcal{A})$. Then for $\widehat{\mathbb{A}}$, in its fullness, a single experimental sampling delivering an unique (individual) result, say $\mathcal{A}_i$, is worthlessly. Such a sampling is not described as a collapse of the probability density $w_{in}(\mathcal{A})$. Moreover a true experimental evaluation of $\widehat{\mathbb{A}}$, in its wholeness and regarded equivalently with a stationary random process, requires [15] an adequate lot of samplings finished through a significant statistical set of individual recordings. In a plausible modeling [16, 17] the mentioned recordings (*rec*) can be described by another probability density $w_{rec} = w_{rec}(\mathcal{A})$.

The above notifications about quantum observables point out clearly the complete incorrectness of item ***I***$_1$. Consequently, even if in the main the item ***I***$_2$ is a true assertion, the subterfuge ***S*** supporting IWFC proves oneself to be nothing but an useless recommendation. Additionally note that, in the mainstream of publications (see [1–3] and references), the respective subterfuge is not fortified with thorough (and genuine) descriptions regarding the collapse $\Psi \longmapsto \psi_i$. Evidently that the above revealed facts ***point out the caducity and failure of IWFC***.

The previous discussions about IWFC lead us also to the following more general Remark (***R***)

R A random variable should not be assessed (measured) by an unique deterministic sampling (trial) but by a statistical ensemble of samplings.

3 Contiguities with the Schrödinger's cat thought experiment

As it is well known [18] the famous Schrödinger's cat thought experiment is a subject often displayed in debates (more or less scientifically) about the significance/interpretations of QM constituents. The essential element in the respective experiment is represented by a killing single decay of a radioactive atom. But the radioactive decays are random (probabilistic) events. Then the mentioned killing decay is in fact a twin analogue of the single sampling noted above in item ***I***$_1$ in connection with IWFC.

The mentioned analogy motivates us to discuss on some contiguities among questions specific to the alluded experiment and those regarding IWFC. We think that, according to the above remark ***R***, the main point of such motivated discussions is to mark down the following Notification (***N***)

N When the variable of interest has random characteristics it is useless (even forbidden) to design experiences or actions that relies solely on a single deterministic sampling of that variable.

In the light of such notification the Schrödinger experiment appears to be noting but just a fiction (figment) without any scientific value. That is why the statements like: "*the Schrödinger cat thought experiment remains a topical touchstone for all interpretations of quantum mechanics*", must be regarded as being worthlessly. (Note that such statements are present in many science popularization texts, e.g. in the ones disseminated via the internet.)

The above notification ***N***, argued for quantum level, can be also of non-trivial significance (interest) at macroscopic scale. For illustrating such a significance let us refer to the thought experimental situation of a classical (macroscopic) cousin of the Schrödinger cat. The regarded situation can be depicted as follows. The cousin is placed in a sealed box together a flask of poison and an internal macroscopic hammer. The hammer is connected to an macroscopic uncontrollable (unobservable) sensor located within the circular error probable (CEP) of a ballistic projectile trajectory. Note that a ballistic projectile is a missile whose flight is governed by the laws of classical mechanics. CEP is defined as the radius of a circle, centered about the mean, whose boundary is expected to include the landing points of 50% of the launching rounds (for more details about ballistic terminology see [19]). The experiment consists in launching of a single projectile, without any possibility to observe the point where it hits the ground. Also the projectile is equipped with a radio transmitter which signals the flight time. If the sensor is smitten by projectile the hammer is activated releasing the poison that kills the cousin. But as the projectile trajectory has a probabilistic character (mainly due to the external ballistic factors) the hitting point is placed with the probability of 50% within the surface of CEP where the sensor is located. That is why, after the projectile time of flight and without opening the box, one can not know the state of living for the cousin. So the whole situation of the classical cousin is completely analogous with the one of quantum Schrödinger's cat. Therefore the thought experiment with classical cousin makes evident oneself as another fiction without any real significance.

We can add here another circumstance where the above notification ***N*** is taken into account (and put in practice) in a classical context. Namely we think that, in the last analysis, the respective notification is the deep reason of the fact that in practice of the traditional artillery (operating only with ballistic projectiles but not with propelled missiles) for destroying a military objective one uses a considerable (statistical) number of projectiles but not a single one.

4 Contiguities with descriptions of quantum measurements

It is easy to see the fact that the considerations from Section 2 are contiguous with the question of QMS descriptions. Such a fact require directly certain additional comments which we try to present here below. In our opinion the mentioned question must be regarded within a context marked by the following set of Topics (***T***):

$\boldsymbol{T}_1$ In its plenitude the QM theory must be considered in a r-QM respectively in an e-QM reading. Fundamentally, on the one hand, r-QM deals with theoretical models regarding intrinsic properties of quantum (atomically sized) systems. On the other hand e-QM has to take into account both the characteristics of measured observable/system and the peculiarities of measuring devices/procedures;

$\boldsymbol{T}_2$ Within r-QM a situation (state/system) is described completely by its intrinsic (*in*) wave function Ψ_{in} and operators $\widehat{A_k}$ ($k = 1, 2, \ldots, f$), associated to its specific observables A_k. Expression of Ψ_{in} is distinct for each situation while the operators $\widehat{A_k}$ have the same mathematical representation in many situations. The concrete mathematical expression for Ψ_{in} may be obtained either from theoretical studies (e.g. by solving the adequate Schrödinger equation) or from a priori considerations (not supported by factual studies). For a given state/system the observables A_k can be put into sight through a small number of global *in*-descriptors such are: *in*-mean values, *in*-deviations or second or higher order *in*-moments and correlations (for few examples see below);

$\boldsymbol{T}_3$ A true experimental evaluation of quantum observables can be obtained by means of an adequate numbers of samplings finished through significant statistical sets of individual recordings. For an observable the samplings must be done on the same occurrences (i.e. practically on very images of the investigated observable and state/system). As regards a lot of observables a global and easy sight of the mentioned evaluation can be done by computing from the alluded recordings some (experimental) *exp*-quantifiers (of global significance) such are: *exp*-mean, *exp*-deviation respectively *exp*-higher order moments;

$\boldsymbol{T}_4$ Usually, a first confrontation of theory versus experience, is done by comparing side by side the *in*-descriptors and *exp*-quantifiers mentioned above in $\boldsymbol{T}_2$ and $\boldsymbol{T}_3$. Then, if the confrontation is confirmatory, the investigations about the studied observable/system can be noticed as a fulfilled task. If the alluded confirmation does not appear the study may be continued by resorting to one or groups of the following upgradings (***u***):
$\boldsymbol{u}_1$) An amendment for expression of Ψ_{in}, e.g. through solving a more complete Schrödinger equation or using the quantum perturbation theory;
$\boldsymbol{u}_2$) Improvements of experimental devices and procedures;
$\boldsymbol{u}_3$) Addition of a theoretical description for the considered QMS;

$\boldsymbol{T}_5$ Through the extension suggested in above upgrading $\boldsymbol{u}_3$ the study changes its reading from a r-QM into an e-QM vision, in the sense mentioned in topic $\boldsymbol{T}_1$. Such an extension needs to be conceived as a stylized representation through a mathematic modeling so that it to include both intrinsic elements (regarding observables/states/systems) and measuring details. Also if the upgrading $\boldsymbol{u}_3$ is adopted then a true confrontation of theory versus experience must be done not as it was mentioned in $\boldsymbol{T}_4$ but by putting face to face the predictions of QMS description with the experimental data.

For an illustration of the topics $\boldsymbol{T}_1$–$\boldsymbol{T}_5$ let us regard as a QM system a spin-less quantum particle in a rectilinear and stationary movement along the Ox axis. The QMS problems will be reported to the orbital observables momentum p_x and energy E, denoted generically by A.

In terms of $\boldsymbol{T}_2$ the probabilistic intrinsic (in) characteristics of such particle are depicted by orbital wave function $\Psi_{in} = \Psi_{in}(x)$ (where coordinate x covers the range Ω). The observables A are described by the associated operators $\widehat{A}$ according the QM rules [6, 7] (i.e. by $\widehat{p}_x = -i\hbar\frac{\partial}{\partial x}$ respectively by the Hamiltonian $\widehat{H}$). Then from the class of global in-descriptors regarding such an observable A can be mentioned the in-mean-value $\langle A\rangle_{in}$ and in- deviation $\sigma_{in}(A)$ defined as follows

$$\left.\begin{aligned} \langle A\rangle_{in} &= \left(\Psi_{in},\ \widehat{A}\,\Psi_{in}\right) \\ \sigma_{in}(A) &= \sqrt{\left(\delta_{in}\widehat{A}\,\Psi_{in},\ \delta_{in}\widehat{A}\,\Psi_{in}\right)} \end{aligned}\right\}, \tag{1}$$

where (f, g) denotes the scalar product of functions f and g, while $\delta_{in}\widehat{A} = \widehat{A} - \langle A\rangle_{in}$.

An actual experimental measurement of observable A in sense of $\boldsymbol{T}_3$ must be done through a set of statistical samplings. The mentioned set gives for A as recordings a collection of distinct values $\{\alpha_1, \alpha_2, \alpha_3, \ldots, \alpha_r\}$ associated with the empirical probabilities (or relative frequencies) $\{\nu_1, \nu_2, \nu_3, \ldots, \nu_r\}$. Usually, for a lower synthesized sight about the mentioned measurement, as experimental (exp) quantifiers are chosen the exp-mean $\langle A\rangle_{exp}$ and exp-deviation $\sigma_{exp}(A)$ given through the formulas:

$$\left.\begin{aligned} \langle A\rangle_{exp} &= \sum_{j=1}^{r} \nu_j \cdot \alpha_j \\ \sigma_{exp}(A) &= \sqrt{\sum_{j=1}^{r} \nu_j \cdot \left(\alpha_j - \langle A\rangle_{exp}\right)^2} \end{aligned}\right\}. \tag{2}$$

The above considerations about an experimental QMS must be supplemented with the following Observations ($\boldsymbol{O}$):

$\boldsymbol{O}_1$ Note that due to the inaccuracies of experimental devices some of the recorded values $\{\alpha_1, \alpha_2, \alpha_3, \ldots, \alpha_r\}$ can differ from the eigenvalues $\{a_1, a_2, a_3, \ldots, a_s\}$ of the operator $\widehat{A}$.

$\boldsymbol{O}_2$ A comparison at first sight between theory and experiment can be done by putting side by side the corresponding aggregate (global) entities (1) and (2). When one finds that the values of compared entities are in near equalities, usually is admitted the following couple of linked beliefs ($\boldsymbol{b}$):

$\boldsymbol{b}_1$) Theory is pretty correct and

$\boldsymbol{b}_2$) Measuring devices/procedures are almost ideal.

Thus, practically, the survey of debated QMS can be regarded as a finished task.

$\boldsymbol{O}_3$ If instead of the mentioned equalities one detects (one or two) flagrant differences at least one of the alluded beliefs ($\boldsymbol{b}_1$) and ($\boldsymbol{b}_2$) is deficient (and unsustainable). Such a deadlock can be avoided by one or groups of the upgradings $\boldsymbol{u}_1$–$\boldsymbol{u}_3$ mentioned above within the topic $\boldsymbol{T}_4$.

Generally speaking the the upgradings $\boldsymbol{u}_1$–$\boldsymbol{u}_2$ are appreciated and worked (explicitly or implicitly) in mainstream literature (see [1–3] and references). But note that, as far as know, for $\boldsymbol{u}_3$ such an appreciation was neither taken into account nor developed in details in the respective literature. It is our modest task to present below a brief exemplification of upgrading $\boldsymbol{u}_3$ in relationship with the QMS question. The presentation is done in some simple terms of information transmission theory.

An information theory modeling for QMS description

In a QMS process the input information regarding the intrinsic (in) properties of the measured system is converted in predicted (pd) or output information incorporated within the data received on a device recorder. That is why a QMS appears as an *information transmission process* in which the measuring device plays the role of a *information transmission channel*. So the QMS considered above can be symbolized as $\Psi_{in} \Rightarrow \Psi_{pd}$ for the wave function while the operator $\widehat{A}$ remains invariant. Such symbolization is motivated by the facts that, on the one hand the wave function Ψ is specific for each considered situation (state/system) whereas, on the other hand the operator $\widehat{A}$ preserves the same mathematical expression in all (or at least in many) situations. Note that the (quantity of) information is connected with probability densities $\rho_\eta(x)$ and currents (fluxes) $j_\eta(x)$ ($\eta = in, pd$) defined in terms of $\Psi_\eta(x)$ as in usual QM [4–7]. Add here the fact that $\rho_\eta(x)$ and $j_\eta(x)$ refer to the positional respectively the motional kinds of probabilities. Experimentally the two kinds of probabilities can be regarded as measurable by distinct devices and procedures. Besides, as in practice, one can suppose that the alluded devices are stationary and linear. Then, similarly with the case of measurements regarding classical random observables [4, 16, 17], in an informational reading, the essence of here discussed QMS description can be compressed [4, 17] through the relations:

$$\left.\begin{aligned} \rho_{pd}(x) &= \int \Gamma(x, x')\, \rho_{in}(x')\, dx' \\ j_{pd}(x) &= \int \Lambda(x, x')\, j_{in}(x)\, dx' \end{aligned}\right\}. \tag{3}$$

Here the kernels $\Gamma(x, x')$ and $\Lambda(x, x')$ include as noticeable parts some elements about the peculiarities of measuring devices/procedures. Mathematically, $\Gamma(x, x')$ and $\Lambda(x, x')$ are normalized in respect with both x and x'. Note that QMS becomes nearly ideal when both $\Gamma(x, x') \to \delta(x - x')$ and $\Lambda(x, x') \to \delta(x - x')$, ($\delta(x - x')$ being the Dirac's δ function). In all other cases QMS appear as non-ideal.

By means of the probability density $\rho_{pd}(x)$ and current $j_{pd}(x)$ can be computed [4] some useful expressions like $\Psi^*_{pd}(x)\widehat{A}\Psi_{pd}(x)$. Then, for observable A, it is possible to evaluate global indicators of predicted (pd) nature such are pd-mean $\langle A\rangle_{pd}$ and pd-deviation $\sigma_{pd}(A)$ defined, similarly with (1), as follows

$$\left.\begin{aligned} \langle A\rangle_{pd} &= \left(\Psi_{pd}, \widehat{A}\Psi_{pd}\right) \\ \sigma_{pd}(A) &= \sqrt{\left(\delta_{pd}\widehat{A}\Psi_{pd}, \delta_{pd}\widehat{A}\Psi_{pd}\right)} \end{aligned}\right\}. \tag{4}$$

If as regards a quantum observable A, besides a true experimental evaluation, for its measuring process one resorts to a (theoretical/informational) QMS description of the above kind the pd-indicators (4) must be tested by comparing them with their experimental (factual) correspondents (i.e. exp-quantifiers) given in (2).

When the test is confirmatory both theoretical descriptions, of r-QM intrinsic properties of system respectively of QMS, can be considered as adequate and therefore the scientific task can be accepted as finished. But, if the alluded test is of invalidating type, at least one of the mentioned descriptions must be regarded as inadequate and the whole question requires further investigations.

For an impressive illustration of the above presented informational QMS description we consider as observable of interest the energy $A = E = H$ regarding a QM harmonic oscillator. The operator $\widehat{H}$ associated to the respective observable is the Hamiltonian $\widehat{H} = -\frac{\hbar^2}{2m}\frac{d^2}{dx^2} + \frac{1}{2}m\,\omega^2 x^2$ (m and ω denote the mass respectively the angular frequency of oscillator). The oscillator is considered to be in its lower energetic level, whose intrinsic state is described by the wave function $\Psi_{in}(x) \propto \exp\left\{-\frac{x^2}{4\sigma^2}\right\}$ (here $\sigma = \sigma_{in}(x) = \sqrt{\frac{\hbar}{2m\omega}}$ denote the in-deviation of coordinate x). Then, because Ψ_{in} is a real function, for the considered state one finds $j_{in} = 0$ — i.e. the probability current is absent.

So for the regarded QMS description in (3) remains of interest only first relation dealing with the change $\rho_{in} \to \rho_{pd}$ of the probability density through the kernel $\Gamma(x, x')$. If the supposed measuring device has high performances $\Gamma(x, x')$ can be taken [4] of Gaussian form i.e. $\Gamma(x, x') \propto \exp\left\{-\frac{(x-x')^2}{2\gamma^2}\right\}$, γ being the error characteristic of the respective device. It can been seen that in the case when $\gamma \to 0$ the kernel $\Gamma(x, x')$ degenerates into the Dirac function $\delta(x - x')$. Then $\rho_{pd} = \rho_{in}$. Such a case corresponds to an ideal measurement. Differently, when $\gamma \neq 0$ one speaks of non-ideal measurements.

In the above modeling of QMS description for the energy $A = E = H$ one obtains [4] the following in respectively pd means and deviations

$$\langle H\rangle_{in} = \frac{\hbar\omega}{2}\,; \quad \sigma_{in}(H) = 0\,, \tag{5}$$

$$\langle H\rangle_{pd} = \frac{\omega\left[\hbar^2 + \left(\hbar + 2m\omega\gamma^2\right)^2\right]}{4\left(\hbar + 2m\omega\gamma^2\right)}\,, \tag{6}$$

$$\sigma_{pd}(H) = \frac{\sqrt{2}m\omega^2\gamma^2\left(\hbar + m\omega\gamma^2\right)}{\left(\hbar + 2m\omega\gamma^2\right)}\,. \tag{7}$$

Relations (5) and (7) show that even if Ψ_{in} has the quality of an eigenfunction for $\widehat{H}$ (as $\sigma_{in}(H) = 0$), due to the measurement Ψ_{pd} is deprived of such a quality (because $\sigma_{pd}(H) \neq 0$).

5 Concluding remarks

We point out, on the one hand, the historical emergence of the IWFC from the conflict between the items $\boldsymbol{I}_1$ and $\boldsymbol{I}_2$ mentioned in Section 2. Then we remind the fact that, on the other hand, the modern studies certify the random characteristics of quantum observables. Therefore a true measurement of such an observable requires a whole set of statistically significant samplings. The respective requirement invalidate indubitably the alluded item $\boldsymbol{I}_1$. So IWFC is proved as a caducous and useless recommendation.

Contiguously the respective proof allows to put into a new light the famous Schrödinger's cat thought experiment. We argue in Section 3 that Schrödinger's experiment is noting but just a fiction without any scientific value. The argumentation relies on the notification that: "When the variable of interest has random characteristics it is useless (even forbidden) to design experiences or actions that relies solely on a single deterministic sampling of that variable". The same notification is useful in appreciating of some non-quantum problems such are a Schrödinger's-type experiment with a classical cat or statistical practices in traditional artillery.

The question of IWFC caducity is contiguous also with the problem of QMS descriptions. That is why in Section 4 we present some brief considerations about the respective problem. Thus we propose that QM theory to be regarded either in a r-QM or in an e-QM reading, as it refers to the studied observables and systems without or with taking into account the QMS descriptions. The proposal is consolidated with simple illustration regarding a spin-less quantum oscillator in a rectiliniar and stationary movement along the Ox axis. Particularly we suggest an approach of QMS descriptions based on information transmission theory.

Of course that other different approaches about QMS descriptions can be imagined. They can be taken into account for extending QM theory towards an e-QM reading, as complete/convincing as possible.

Submitted on: November 15, 2012 / Accepted on: November 18, 2012

References

1. Weinberg S. Collapse of the state vector. *Physical Review A*, 2012, v. 85, 062116; arXiv: 1109.6462.
2. Ghirardi G. Collapse theories. *The Stanford Encyclopedia of Philosophy*, Winter 2011 Edition, Stanford.
3. Omnes R. Decoherence and wave function collapse. *Foundations of Physics*, 2011, v. 41, 1857–1880.
4. Dumitru S. Reconsideration of the uncertainty relations and quantum measurements. *Progress in Physics*, 2008, v. 2, 50–68.
5. Dumitru S. Do the uncertainty relations really have crucial significances for physics? *Progress in Physics*, 2010, v. 4, 25–29.
6. Cohen-Tannoudji C., Diu B., Laloe F. Quantum Mechanics. Vol. I. J. Wiley/Herman, NY–Paris, 1977.
7. Schwabl F. Quantum Mechanics. 2nd. rev. ed., Springer, Berlin, 1995.
8. Dumitru S. The Plank and Boltzmann constants as similar generic indicators of stochasticity: some conceptual implications of quantum-nonquantum analogies. *Physics Essays*, 1993, v. 6, 5–20.
9. Munster A. Statistical Thermodynamics. Vol. I, Springer, Berlin, 1969.
10. Landau L., Lifchitz E. Physique Statistique. Mir, Moscou, 1984.
11. Schwabl F. Statistical Mechanics. Springer, Berlin 2002.
12. Dumitru S. Fluctuations and thermodynamic inequalities. *Physica Scripta*, 1974, v. 10, 101–103.
13. Dumitru S., Boer A. Fluctuations in the presence of fields — phenomenological Gaussian approximation and a class of thermodynamic inequalities. *Physical Review E*, 2001, v. 64, 021108.
14. Boer A., Dumitru S. Higher order correlations in the presence of fields. *Physical Review E*, 2002, v. 66, 046116.
15. Korn G.A., Korn T.M. Mathematical Handbook for Scientists and Engineers. Chap. 19, McGraw Hill, New York 1968; Russian version — Nauka, Moscow, 1977.
16. Dumitru S. Phenomenological theory of recorded fluctuations. *Physics Letters A*, 1974, v. 48, 109–110.
17. Dumitru S., Boer A. On the measurements regarding random observables. *Romanian Journal of Physics*, 2008, v. 53, 1111–1116; http://www.nipne.ro/ rjp/2008_53_9-10.html
18. Schrödinger's cat. http://en.wikipedia.org/wiki/Schrödinger's_cat
19. Category: Ballistics. http://en.wikipedia.org/wiki/Category:Ballistics