**(March 2019) Gabriel Vacariu: UNBELIEVABLE similar ideas of Brukner (2015) on quantum mechanics and my ideas (2002-2006)**

[In this article, I investigate the UNBELIEVABLE similar ideas of Brukner’s article (2015) and my ideas (2002-2008) In this article, I investigate the UNBELIEVABLE similar ideas of Brukner’s article (2015) and my ideas (2002-2008) I emphasize that this paragraph is not from my works!! Instead of “objectivity of the ‘facts of the world’, I used EDWs! All the ideas from this paragraph (and the philosophical ideas referring to QM from this article, can be found in my works 2002-2008!]

Cˇaslav Brukner (2015) On the quantum measurement problem

1;2

1Faculty of Physics, University of Vienna, Boltzmanngasse 5, A-1090 Vienna,

Austria.

2Institute of Quantum Optics and Quantum Information, Austrian Academy of

Sciences, Boltzmanngasse 3, A-1090 Vienna, Austria.

arXiv:1507.05255v1 [quant-ph] 19 Jul 2015

Abstract

In this paper, I attempt a personal account of my understanding of the

measurement problem in quantum mechanics, which has been largely in the

tradition of the Copenhagen interpretation. I assume that (i) the quantum

state is a representation of knowledge of a (real or hypothetical) observer

relative to her experimental capabilities; (ii) measurements have definite

outcomes in the sense that only one outcome occurs; (iii) quantum theory

is universal and the irreversibility of the measurement process is only “for

all practical purposes”. These assumptions are analyzed within quantum

theory and their consistency is tested in Deutsch’s version of the Wigner’s

friend gedanken experiment, where the friend reveals toWigner whether she

observes a definite outcome without revealing which outcome she observes.

The view that holds the coexistence of the “facts of the world” common both

for Wigner and his friend runs into the problem of the hidden variable program.

The solution lies in understanding that “facts” can only exist relative

to the observer.

[The reader can already notice the UNBELIVABLE similarities between my ideas referring to QM and Brukner’s ideas!!]

In the following, I would like to present a personal account of my understanding

of the measurement problems in quantum mechanics. My intention is not to

argue that the approach I chose is the “best” way in any particular sense, but rather

to demonstrate its logical consistency and to investigate what consequences the requirement

for its consistency have for our understanding of physical reality. I will

first present a probabilistic argument that explains why the measurement process

is irreversible “for all practical purposes”. Furthermore, by analyzing Deutsch’s

version of the Wigner’s friend gedanken experiment, I will show that any attempt

to assume that the measurement records (or “facts” or experiences) that coexist

for both Wigner and his friend will run into the problems of the hidden variable

program, for which I propose a Bell-type experiment. The conclusion is that these

records can have meaning only relative to the observers; there are no “facts of the

world per se”.

Although I see my view of the quantum measurement problem broadly in the

tradition of the Copenhagen interpretation, particularly within the informationtheoretical

approach to quantum mechanics [4], it contains elements from Qbism [5],

the relative interpretation of Rovelli [6] and even the many-worlds interpretation. (p. 2)

[Clearly we have here the framework of my EDWs since there are no “facts of the

world per se”!!! The concept “coexistence” refers directly to the EDWs and not the “world”; with my EDWs, I rejected exactly the “world”, Universe or as I called, the unicorn-world! Of course, the author mention Rovelli and many-worlds, but he emphasizes he introduces something new! UNBELIVABLE!!!]

The solutions to the small measurement problem which have been o\_ered to

date basically present two underlying premisses. They either introduce “hidden”

causes that determine which outcome will occur in a given experimental run (as in

Bohm’s hidden-variables theory), or they refute the basic notion of measurements

resulting in definite outcomes (as in the Everett interpretation). None of that is

really necessary. My position is that measurements have definite outcomes in

the sense that only one outcome can be the result of a single experimental run.

This is rather obvious. If it were otherwise, the notion of measurement would

become ambiguous. If the outcome is not definitive, then no observation has

occurred. This, however, does not exclude the possibility that the conditions that

define a measurement are fulfilled for one observer but not for another. (p. 2)

[I draw the attention to the reader this paragraph is not from my works! UNBELIEVABLE similar ideas to my ideas from 2002-2008!]

I would like to express clearly that I do agree with the Qbists and the Copenhagenists

on the necessity of a functional distinction between the object and the

subject of observation. This distinction is at the heart of Bohr’s epistemological

argument that measurement instruments lie outside the domain of the theory,

insofar as they serve their purpose of acquiring empirical knowledge. Regretfully,

this argument has repeatedly been misinterpreted in textbooks and articles and “replaced by the crude physical assumption that macroscopic systems behave

classically, which would introduce an artificial split of the physical world into

a quantum microcosms and a classical macrocosms.” [14]. The “cut” is not between

the macro and micro worlds but between the measuring apparatus and the

observed quantum system. It is of epistemic, not of ontic origin. (p. 4)

[in my works 2002-2005-2006, etc. I investigate exactly the same distinction in exactly the same framework. However, I talked about epistemologic-ontologic distinctions!]

Bohr and Heisenberg seem to have disagreed about the movability of the

cut [15]. As Heisenberg recalls in his letter to Heelan [16] (quoted in Ref. [15]):

“I argued that a cut could be moved around to some extent while Bohr preferred

to think that the position is uniquely defined in every experiment”. In my understanding,

the two views are not conflicting and can be brought into accordance. (p. 5)

[Really? Under what framework? Under the unicorn world? Or the EDWs????]

The “wave function of the universe” that would

include the observer is a problematic concept, as it negates the necessity of the

object–subject cut.). This is compatible with Malin’s view [19] that “quantum

states represent the available knowledge about the potentialities of a quantum system,

knowledge from the perspective of a particular location in space”, not of any

actual observer.

I share Malin’s view on the meaning of the quantum state, which is essentially

the one supported by Copenhagenists and Qbists. I would like to add just one, but

an important, aspect to this view: The quantum state is a representation of knowledge

necessary for a hypothetical observer – respecting her experimental capabilities

– to compute probabilities of outcomes of all possible future experiments. An

explicit reference to the observer’s experimental capabilities is crucial to address

the big measurement problem. (p. 6)

[Clearly, we have here the EDWs perspective!!! Does the reader want more details? See below…]

Since Q() represents a complete description of the system under coarse-grained

measurements, I will call it the “macroscopic state”. This approach to classicality

di\_ers conceptually from and is complementary to the decoherence program

that is dynamical and describes correlations of the system with other degrees of

freedom which are integrated out [28]. (p. 7)……

… The macroscopic states are robust. This means that they are stable against perturbations,

which may for example be caused by repeated coarse-grained observations.

In other words, the Q-function before and after a coarse-grained measurement

is approximately the same [29]. It therefore becomes possible for different

observers to repeatedly observe the same macroscopic state. The result is a certain

level of intersubjectivity among them. If we assume, however, that quantum

mechanics is universally valid, then it is in principle possible to undo the entire

measurement process. Imagine a superobserver who has full control over the degrees

of freedom of the measuring apparatus. Such a superobserver would be able

to decorrelate the apparatus from the measured system. In this process, the information

about the measurement result would be erased. Seen from this perspective,

“irreversibility” in the quantum measurement process merely stands for the fact

that it is extremely difficult – but not impossible! – to reverse the process. It is irreversible “for all practical purposes” (or “FAPP,” to use Bell’s acronym).

I have often heard the following objection to FAPP: No matter how low the

probability is to reverse the evolution in the measurement process, it is still there.

How is it possible to settle the question of what actually exists by an approximation?

In my eyes, such questions do not take into consideration the simple fact

that quantum theory cannot be both, universal and not irreversible merely FAPP.

While on the one hand, measurements have to result in irreversible facts (otherwise,

the notion of measurement itself would become meaningless, as no measurement

would ever be conclusive), this irreversibility on the other hand must

be merely FAPP if quantum theory is in principle applicable to any system. Any

system means that the measuring apparatus itself can also be subject to the laws

of quantum theory. My main point is the following. While it is obviously possible

to describe the subject as an object, it then has to be the object for another

subject. In my eyes, not enough thought has gone into the fundamental nature of

FAPP. More research on the philosophy of FAPP, if you like, should be done by

philosophers of physics. This, in my eyes, would contribute to the resolution of

the problem in a much deeper way than the perpetual attempts to expel this term

from the foundations of physics based on presupposed philosophical doctrine. (pp. 9-10)

[of course, we are here within the macro-EW, as I called it! All the main ideas from this paragraph can be found in my works! It is about the EDWs, no more or less!]

Detection devices, such as photographic plates or photo-diodes, consist of a

large number of constituents in a certain “metastable state”. Their interaction

with the observed quantum systems brings them into a “stable state” that can be

distinguished from the initial one even under coarse-grained observations. This

transition is signified by the “click” in the detector or a new position of the pointer

label. In both the metastable and the stable state, the constituents of the instrument

can be in any of a large number of quantum states that correspond to the

respective macroscopic states. In order to understand how irreversibility FAPP is

possible, it is crucial to realize that not only the initial and final quantum states

of the instrument are imprecisely known, but also the full details of the interactions

(i.e. Hamiltonian) among its constituents and with the environment. Even if

it were possible to know the initial and final states precisely, the lack of precise

knowledge of these interactions prevents us from reversing the measurement process. (p. 10)

What will be written in the message? Will the superobserver see the interference?

Three di\_erent results of the experiment are possible9:

1. The quantum state collapses due to a breakdown of the quantum-mechanical

laws when applied to states of brain or to systems of su\_ciently large

size, mass, complexity, and the like. The collapse models Ghirardi-Rimini-

Weber [8] or Diosi-Penrose [9, 10] fall into this category. One could also

argue in favor of the collapse within the view according to which a quantum

state is a representation of the observer’s knowledge. Every measurement

yields new information, and the representation of this knowledge update

is the state projection. Since the new information about the outcome is

available somewhere – specifically in the observer’s brain – the state has to

collapse for all observers, including the superobserver10. Independently of

the specific rationale behind the state collapse, the observer sends the message

that she observers a definite outcome. The superobserver concludes

that although he could exclude all known e\_ects caused by conventional

decoherence, the state is not in the superposition. This he can confirm in the interference experiment by observing that both outputs in the interference

experiments occur with equal probability.

2. The superobserver’s state assignment is the superposition state, and the observer

perceives a “blurred reality” that she associates with not seeing a

definite outcome. She sends a message: “I observe no definite outcome”.

The superobserver confirms the superposition state in the interference experiment

by observing a single output state in the interference experiment.

I personally have trouble to make sense of this option. If quantum theory

describes an observer’s probability assignments in well-defined experimental

procedures, where, to quote Bohr [41] “... by the word ’experiment’ we

refer to a situation where we can tell others what we have done and what we

have learned ...”, then experience of “blurred reality” seems to be outside of

the standard quantum framework. Moreover, such a situation would install

a fundamental asymmetry between the observers, those who see and those

who do not see “blurred reality”.

3. The quantum laws are unmodified. The superobserver’s state assignment is

the superposition state. And yet, the observer observes a definite outcome.

The assigned superposition state can be confirmed in the interference experiment.

In my eyes, outcomes 1 and 2 would indicate fundamentally new physics. I

will not consider these cases further and regard quantum theory to be a universal

physical theory. This leaves us with situation 3 as the only possible outcome

of Deutsch’s thought experiment. The outcome is compatible with the Everett

interpretation: each copy of the observer observes a definite but di\_erent outcome

in di\_erent branches of the (multi)universe. The outcome is compatible with the

Copenhagen interpretation too, but it is rarely discussed what the implications of

this claim are for our understanding of physical reality within the interpretation.

The rest of the current manuscript is devoted to this problem.

Note that in situation 3 of the thought experiment, the two observers have complementary

pieces of information. Taken together, they would violate the complementarity

principle of quantum physics. The observer has complete knowledge

about the value of observable A1 with eigenstates jz+i1jz+i2jz􀀀i3jknows “up”i4

and jz􀀀i1jz􀀀i2jz+i3 jknows “down”i4, whereas the superobserver has complete

knowledge about the value of observable A2 with eigenstates j +i and j 􀀀i. The

two observables are non-commuting. One might be tempted to interpret outcome 3 of Deutsch’s experiment as implying that the two pieces of information coexist.

After all, the superobserver has evidence – in form of the message – that the

observer had perfect knowledge about A1. And yet, on the very same state (13),

he can learn the value of A2. Even the observer herself, retrospectively, after

completion of the interference experiment, can be convinced that there is a discrepancy

between her message and the fact that she always ends up in one output

state in the interference experiment (thereby forgetting which outcomes she had

observed). This is because, if she previously were in a state observing a definite

outcome, then by applying standard quantum mechanical predictions on the

systems and herself (which in itself is a problematic step because it ignores the

necessity of the object-subject cut), she should have equal probability to end up in

either of the two output states. (pp. 18-20)

[again, we can see here UNBELIEVABLE similar ideas to my EDWs!!! Many such UNBELIEVABLE similar ideas can be found in my works 2002-2008!]

What consequences does outcome 3 of Deutsch’s thought experiment have

for our understanding of physical reality? Let us assume that the observers’

and superobservers’ laboratories contain a large number of degrees of freedom

which allow the information about respective measurement records to be FAPP redundantly imprinted in their respective “environments”. I will call these records

“facts”. This could be a click in a photodetector, a certain position of a pointer

device, a printout of a computer or a written page in the lab-book, or a definite

human brain state of a colleague who read the lab-book. If we assume that all

these records in the observer’s laboratory get correlated with the spin atoms and

her brain state, and the superobserver can still perform the interference experiment,

the result of which is also recorded in his laboratory, one has to accept that

the two pieces of information can redundantly be imprinted in two environments:

the sealed laboratory and the outside, respectively. As long as there is no communication

on the relevant information (the actual measurement outcome) between

the two laboratories, they will remain separate.

If we respect that there should be no preferred observers, then there is no

reason to assume that the “facts” of one of them are more fundamental than those

of the other12. But then, the observers’ records cannot be comprised as “facts of

the world”, independent of the “environment” in which they have occurred. Any

attempt to introduce “facts of the world per se” would run into problems of the

hidden variable program. (pp. 21-22)

[It is clearly UNBELIEVABLE similar to my EDWs!!!!]

[The author continues:]

The implications of the present Bell experiment are stronger than those of the

standard Bell test. In the latter, we can exclude the view according to which the

outcomes for measurements are (locally) predetermined, no matter if any measurement

– and no matter which measurement – is actually performed. Still, between

the partners there is no ambiguity with respect to whether measurements

take place and about the coexistence of their records. The records can be accomplished

as “facts of the world”, which they share and even need to communicate

in order to evaluate the experimental bound of the Bell expression. This is no

longer the case in the present Bell experiment. What the Bell experiment excludes

is the coexistence of the “facts” themselves. Everettians solve this by assuming

that mutually complementary facts never coexist in between two branchings

of the (multi)universe. Copenhagenists (can) take the position that there are no

facts of the world per se, but only relative to observers. This is similar to Quantum

Bayesianism, which treats the state of a quantum system as being observerdependent,

and to Rovelli’s relational quantum mechanics [6], according to which “quantum mechanics is a theory about the physical description of physical systems relative to other systems ...” There are, however, important differences.

In Rovelli’s relational interpretation, the “observer” does not “make any reference

to a conscious, animate, or computing, or in any other manner special,

system” [6] – each system provides its own frame of reference relative to which

states of other systems can be assigned. Taking this position and outcome 3 of the

Deutsch’s experiment and applying them to, for example, the interference phenomenon

in the double-slit experiment with single electrons, one would conclude

that, although the observer has no path information, the electron itself “knows”

which path it takes. Relative to the electron, a definite path is taken, although we

as observers observe an interference pattern. Obviously, we are here encountering

the limits of meaningful language when we associate the terms “knowledge”

or “taken” to single electrons. In this respect, quantum theory (in my eyes) remains

a fundamental theory of observations in which a (hypothetical) observer,

measurement and probabilities play a central role. (pp. 22-23)

[Obviously, the difference between carlo rovelli’s approach and my EDWs is that rovelli has been working within the unicorn world until 2016!!! His name is included in this manuscript about UNBELIEVABLE similarities….]

The di\_erence to the Everett interpretation is more evident. In the view adopted

here, no meaning is given to “the universal wave function”, nor is there an attempt

to arrive at the probabilities from within such a concept alone. Here, the probabilities

are always given by the Born rule, which is part of the formalism. This

applies also to superobservers of any order: probabilities acquire meaning only

when the measurement arrangement is specified, in which these probabilities are

observed. (p. 24)

[Obvisouly, there are strong differences between Everett’s many words and my EDWs!!!! See my works!]

Finally, I comment on the view [45] that the cut cannot be moved to include

measurement instruments, observers etc. as objects under observation, since an

object can never grow up to the point that it includes measurement contexts that, in

turn, are unavoidably given in terms of classical concepts in accordance to Bohr’s

doctrine [39]: “However far the (quantum) phenomena transcend the scope of

classical physical explanation, the account of all evidence must be expressed in

classical terms.” According to this view [45], the necessity of unambiguous usage

of classical concepts fixes the object-subject cut whose position is therefore fundamental

and equal for all observers. Consequently, one can retain the objectivity of

the “facts of the world”. I do not think that this view stands up to closer scrutiny.

The description of any quantum mechanical experiment is expressed “in common

language supplemented with the terminology of classical physics” [46]. Although

this observation has played an important role in clarifying misconceptions in debates

over the interpretation of quantum theory, it is in retrospective rather selfevident.

For example, the description of a double-slit experiment with atoms, includes

the depiction of the source of atoms directed towards the diaphragm normal

to the beam, where the diaphragm contains two slits and a photographic plate with

a characteristic interference pattern on the plate where the atoms are deposited. By

extending the experiment to larger and larger systems, eventually as large as measurement

instruments, nothing should change in the epistemic basis of the theory:

we will still give an unambiguous account of the phenomenon in terms of classical

language including a suitable “source”, “beam” and “observation screen”.

This should not be confused with the impossibility of giving a classical explanation

of the phenomenon, e.g. in terms of well-defined classical trajectories, which

is present both for atoms and for macroscopic objects. To conclude, the cut can

be shifted with no change in the epistemic foundation of the theory. Negating

this would either mean negating Wigner-type experiments as legitimate quantum

mechanical experiments or predicting outcome 1 in Deutsch’s experiment. Both

choices indicate an acceptance that quantum theory is not universal. (p. 24)

[Again, I emphasize that this paragraph is not from my works!! Instead of “objectivity of the ‘facts of the world’, I used EDWs! All the ideas from this paragraph (and the philosophical ideas referring to QM from this article, can be found in my works 2002-2008!!!]