NOTES ON THE INFORMAL DISCUSSION OF 30.09.11

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MATERIAL FOR FURTHER DISCUSSIONS

1. “Reality as the sum of all constraints” – should it be understood as “reality” being the objective constraint on the minimal common content of possible descriptions/theories?

a. Some definition of “objective” is necessary, but the existence of “objective” – at least as “independent on the particular conscience” – is a must, otherwise there is no point discussing these (or any) matters with figments of one’s imagination.

2. Important *technical* question: why *only a few* (of many possible) observables (self-adjoint operators) have classical counterparts? Does this have something to do with the above-mentioned “constraints”?

3. A related question: How does the classical reality – i.e. the behaviour of objects consistent with classical dynamics (and eventually *thermo*dynamics) emerge out of the quantum world? Is there any relation between this emergence and the thermodynamical time arrow?

4. Is mathematics one of these constraints?

5. What are the correspondence rules for mathematics in different theories?

6. What is the meta-level to define and describe these problems? How does the choice of the metalanguage influence the discussion?

1. Is that metalanguage - logic? Mathematics? Philosophy? How do we tell the difference?
2. What kind of a metatheoretical environment is needed in order to formulate any reasonable (=testable?) questions and hypotheses?

7. Is consciousness to be explained in terms of quantum theory, which is considered basic (and “real”), or the other way around?

8. Quantum measurement will be viewed as a process which is stretched in time and (somehow) controlled, and not as a black-box instantaneous action.

9. What are the philosophical problems for mathematics arising from the further development of physics – does it retain its a priori status, or is it just a part of the language we use (which is such-and-­such as it developed evolutionary in order to serve the needs of physics)?

10. Can the study of metamaterials provide any insight into the nature of mathematics?

a. Can the outcome of the metametarial project have a direct impact on the understanding the nature of mathematics (this would be very strange – but not totally impossible, if we manage, e.g., to touch the relation between “reality” and “image”, or the “rise of objectivity”)

11. What is *special* about the metamaterial project, which could possibly affect the view of mathematics and the relationships between math, physics, philosophy? (Possibly the attempt at directly investigate how the formation of image shapes the rise of reality?)

a. What is the important conceptual difference in the metamaterial project view compared to the classical QM-view? Is this the fact, that macroscopic object is expected to exhibit essentially quantum behaviour?

12. What kind of outcome of the project would in any sense put the philosophical discussion forwards

a. Imagine that we succeed in the project and the outcome is such-and-such. What does it mean for philosophy? What does the failure mean?

b. Would that affect the notion of truth in *mathematics?*

c. Could – in any sense – philosophical questions be resolved by an experiment – i.e.: does the project somehow contribute to that? (Possibly yes – e.g., if we can formulate the philosophical notion of objective reality as an “emergent phenomenon” (current newspeak for the old Hegelian “quantitative-into-qualitative” transition) in such a way that its “emergence” can be quantified).

13. Our theories and mathematics are all the time under construction – how to reconcile this with the realistic worldview, especially concerning quantum reality? Is it not just a very strong and unjustified assumption? (Here we need to properly define the “realistic worldview” – and recognize that our theories, however changing and imperfect, retain the basic consistency and predictive ability – which is refuting the “Neurath’s boat” argument)

14. Is the role of mathematics in any way different in the project that in any other branch of physics? Or is it just the role of providing a language and framework to work in?

(The answer is most probably negative – but …)

15. What if some mathematical tools applied in the project(or any other) turn out to be independent (in the logical sense) of the current mathematical axioms? Would they simply be used regardless of the fact, that this is not standard mathematics?

a. There are some results of theorems, which are claimed (by the authors) to have some physical interpretation, and which are independent from the current set theoretical (i.e. ZFC) axioms. What is the status of such sentences? Are they "tested experimentally"?

16. Mathematics is a part of science:

a. Either in the sense of the logical positivists (as a conceptual scheme)

b. Or in the Quinean picture – as a part of the ontology needed in order to make science

17. What if we give an instrumentalist interpretation of mathematics: where is the borderline between language, linguistic concepts etc and reality? How could we tell, that there is an underlying reality (e.g at the quantum level) in an objective, robust sense of this word, if our "grasp" of that world is only via invented conceptual systems (mathematics)?

a. Could the theory of metamaterials contribute to that problem?

18. Quine'an indispensability argument for realism (mathematics is indispensable in science and should not be treated just as an conceptual apparatus, but on a par with other fragments of theories): is the project relevant to that argument?

a. Are the macroscopic quantum system somehow "more real" that the microscopic ones? Why? Is therefore the mathematics involved more "real" in any reasonable sense of that word?

19.Are these macroscopic quantum phenomena in project somehow more close to our everyday experience (like billiard balls etc)? What kind of experiments can we propose to test this difference/similarity?

20. If a macroscopic system exhibits quantum behaviour, what does it mean? Is it that the description of the probabilistic behavior of the system is best given in the language of QM, or is it – in any sense – *really* quantum (whatever that means)?

21.Assume, that the project succeeds. What does it mean for philosophy? Will it undermine the positivist-Kantian approach (a la d’Espagnat) or strengthen it?

22. Is the assumption of an extra-linguistic, objective reality somehow more reliable in the case of e.g. classical mechanics that in QM? Is the metamaterials project an intermediate stage?

23. Is reality is to be characterized as the bundle of invariants of possible mathematical descriptions/theories?

a. What is the "logical space" of these theories? Are they all located within a kind of a common, general logical framework (some kind of a basic mathematical theory like set theory)?

b. This logical space is restricted by our conceptual abilities. So – in a sense – reality is inherently constrained by our conceptual apparatus. And it suddenly seems to become some kind of conceptual construct which leads to an idealistic stance, we rather would not like to adopt. So...

c. Or is it rather, that mathematics reflect the structure of the universe directly but this seems to be a kind of Platonism, of a vague kind. How to make it more distinct?

d. So what is the proper philosophical interpretation? Is it a new one, which is not already present in the philosophical discussion?

i. Does the project contribute here?

24. What is really new about project from the a. Physical, b. Mathematical, c. Philosophical points of view? d. Isn't is just the case, that the project is just another successful (hopefully!) application of mathematics in physics, but from the standpoint of the discussion of the status of maths it does not contribute?

e. Is there a new physical principle, or is it just a non-standard application (in the sense: of physical notions, which have not been applied before to such phenomena)?

25. Mathematics is still under construction, yet it is generally perceived to be constrained by some version of set theory (i.e. the whole of mathematics can formally be reconstructed within ZFC, just like you can reconstruct the reals from the rationals via Dedekind cuts, or the rationals out of the whole numbers by equivalence classes etc.) So the proper formal framework for reconstructing mathematics seems to be ZFC. But it was invented 100 years ago out of some a priori considerations of Cantor, Zermelo and others!

a. So the "logical space" (for the project project) has been given a priori 100 years ago?

Not if we admit new constructions such as the Noncommutative geometry. There is more mathematical calculating in physics than there is mathematics, e.g. the Quantum Field Theory is not rigorously correct. Also, there are known problems with the Feynman diagrams, path integrals, etc etc. In general, formal calculations often make more sense in physics than the rigorous ones. Such calculations have been interesting to mathematicians as well, e.g. Euler was a master of calculating with divergent series. Some if it is masterful and seems to possess deeper meaning that goes beyond the standard analysis. (Heaviside’s operational calculus, asymptotic analysis, generalized functions – but these were later shown to have a rigorous foundation. Can we always count on this? Why?)

Does this suggest that the "constraint of mathematics" is too rigid? Does physics flow outside the mathematical description of math? If so, is it inherent and permanent or only temporary, until better math is invented?

What is behind the ability of incomplete, inconsistent and outright illegal mathematical procedures routinely employed by physicists to lead to correct predictions? Is there a limit of such “undeserved good luck”?

26. VVhy is progress in this project more relevant for the philosophical discussion that e.g. general relativity, standard QM etc? Or is it?

27.A thought experiment: what if a system of the size of a house could be built which exhibits quantum behavior (the Schrodinger cat...)? What actually would it mean, that it “really” exhibits quantum behavior?

a. And what if the collapsing process would last a week? Does such a thought experiment make sense? Would it be reasonable to describe the measurement process as something which lasts a week and is a certain function from the time interval into... (the appropriate Hilbert space)?

b. Would we say, that this is really such a temporal process, or rather, that this kind of formalism is more convenient?

c. Would there be any kind of empirical access to the "transition states"? Does such a question even make sense?

In what type of mathematical structure/model best describes the quantum measurement processes? Can this be standardized? For example, can we say that there ought to be a coupling of a classical (or nearly classical in the sense of M. Everitt et al. PRA 2010 article) system to a quantum one? Does there have to be a coupling to the "environment"?

29. A question regarding the emergence of individual entities from the mathematical point of view: How can a Hilbert space "split" into a tensor product of two Hilbert spaces? *It feels as though this bit of math is missing -- has never been invented.*