# Review of: "The new partitional approach to (literally) interpreting quantum mechanics"

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Potential competing interests: No potential competing interests to declare.

Report on the paper

The new partitional approach to (literally) interpreting quantum mechanics

By David Ellerman

Summary:

The paper proposes, as an epistemological thesis, the interpretation of quantum states by “objective indefiniteness”, inspired by the Literal Interpretation of QM proposed by A. Shimony.

It is developed by converting the maths of Hilbert spaces into an algebra of sets.

To this aim, in section 2 an algebra of partitions originated by equivalence relations, considered as the key to treat distinctions vs indistinctions and hence definiteness vs indefiniteness, is introduced. An interesting observation about the compositional vs holistic attitude is also suggested (end of page 2).

The logic of partitions is briefly commented in section 3 and in section 4, inspired by Gian Carlo Rota, the idea of Logical Entropy is introduced from partitions. It allows a direct reading of probabilities in terms of information.

Then the representation of “skeletonized quantum states” is introduced and illustrated in section 5, and commented in terms of Leibnitz’s principles.

Section 6 comments on waves and provides imagery of “superposition and indefiniteness” by figure 4.

Then the correspondence between the algebra of Hilbert spaces and that of partitions is detailed:

Section 7 finds the density matrix of a state that corresponds to a partition, by writing the convex combination of the projectors that in turn correspond to the subsets composing the partition itself. Section 8 characterizes the Hermitian operator of an observable by considering the blocks of a given partition as the eigenspaces of the eigenvectors for any eigenvalue. Section 9 analyzes projective quantum measurement by considering the Lüders mixture operation. An example is given. Then logical entropy is reconsidered and applied.

Section 10 considers the case of different compatible/incompatible observables, then Feynman’s point of view about

measurement, then the characterization of unitary transformations as those preserving the inner product, namely the degree of indistinguishability, then Weyl's imagery and finally, it describes the double-slit experiment in terms of sets and partitions.

Comment:

The paper is well organized and overall it is clear, even if some explanation could be expanded. The references are adequate. It provides an original view of QM, by a peculiar analysis of equivalence relations and set partitions (based also on previous works). Its results are important, on one side, in the interpretation of QM, since it can introduce the focus on definiteness vs indefiniteness, that sometimes is not even considered, as stressed by the author himself. Such a focus can motivate the application of quantum mechanics to different fields (see also the observations below). In particular, the idea of logical entropy allows us to read probabilities in terms of information and hence to appreciate the informational content of quantum states or of any object whose description requires to consider an indefinite component.

Moreover, the approach introduced in the paper can easy and clarify the reading of the algebra of Hilbert spaces: density matrices and Hermitian operators, as well as the interpretation of quantum measurement and of unitary transformations, supporting such an interpretation by quotations of authors such as Feynman and Weyl.

Observations and hints:

Section 2 line 4: notation: what is ")" ?

Section 3: a reference for $\Pi(U)$ could be added.

Section 4: the author could better organize and comment the introduction of $h(\pi)$ and in particular the last equality in the second displayed formula.

Section 5: in my idea a quantum sharp state is not classical at all, since one has uncertainty in QM. Then, rather than classical, I would say "sharp" (that only refers to one observable). This would even fit better with the ideas of the paper I think.

Section 6: a wave could be considered as an intrinsically undefined object, then, in my opinion, no need to fight the idea of wave in itself. The need of complex numbers is not confined to the solution of the eigenvalues equations. In quantum superposition the relative phase in the coefficients is what can determine the indistinguishability.

Section 9: It would be informative to see the proof of the theorem stated on page 10. It would be informative to see explicitly the computation or at least the final result of the Lüder mixture operation for the given example.

To the purpose of sharing ideas and knowledge only: If interested, the author might consider a different logical approach to quantum states that can describe an "objective indefiniteness" as well, contained in the paper (with the references therein):

· G. Battilotti, *Quantum states as virtual singletons: converting duality into symmetry.* Int. J. Theor. Phys. 53 (2014), 3488-

3502 (Proceedings of the 11th Biennial Meeting of the International Quantum Structures Association, Cagliari, July 2012).

Then the approach has been applied to formalize psychoanalytic models of the mind, requiring a formal approach to indefiniteness as a basic component of our thinking, see (with the references therein):

· G. Battilotti, M. Borozan and R. Lauro Grotto, *The Modal Components of Judgements in a Quantum Model of Psychoanalytic Theory*. Entropy 2023, 25, 1057.