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# ONTOLOGICAL MINIMALISM: COMMENTS ON PETER LEWIS

In Peter Lewis' example, we have an electron e which is in a superposition of two z-spin eigenstates: $1/\sqrt{2}\,(\text{spin-up}(e) + \text{spin-down}(e))$. Such superposition states are characteristical for quantum mechanics, for only they can explain the various interference phenomena of microphysical entities. However, what we really observe are never superposition-states but always eigenstates: either spin up or spin down. The measurement problem of quantum mechanics is its incapability of giving an explanation of this measurement phenomenon in terms of its theory, namely in terms of the Schrödinger equation. For, assuming the system consists of the electron together with a measurement device and an observer, the final result according to the Schrödinger equation will always be a superposition of two states – the first where the observer observes the measurement device signaling spin up, and similarly the second with spin down. This is described in Lewis' equation (2). But what we really experience is either the first or the second state, as described in Lewis' equations (3) and (4).

As Peter Lewis explains, there are (at least) two ways of quantum mechanics to avoid inconsistency with experience. Both theories introduce *ad hoc* assumptions about *hidden* entities without any further physical explanation. Crucially, these hidden entities are assumed to vary in accordance with the Schrödinger statistics. Collapse theories assume that at some time during the measurement process the system in superposition-state collapses into an eigenstate. Thus, collapse theories assume a hidden process with variable outcome (spin up or spin down), statistically fitting with the Schrödinger statistics. No-Collapse theories, on the other hand, assume hidden entities in varying states which cause the observation of spin up or spin down eigenstates, again in accordance with the Schrödinger statistics. In the worlds or minds interpretation, for instance, the chances of the observer to find himself in a world or mind where the spin of the electron is (observed to be) up or down, respectively, are equal. Similarly in the pilot wave theory, the chances of the particle – which is assumed to 'surf' somehow on the wave function described by the superposition state – to 'splash' into the 'spin up'-valley or into the 'spin down'-valley are equal.

I think it to be rather obvious that all versions of theories *ad hocly* assume some additional entities – here processes, there objects – with the *only* function to make quantum mechanics coherent with experimental data. I agree with Peter Lewis that collapse theories and the pilot wave theory are preferable as against the many worlds and the many minds approaches, because the latter introduce hidden entities which are completely *non-physical* while the former try to keep their hidden entities at least as 'physical' as possible. But if we compare the collapse approach with the pilot wave approach, then Lewis' remarks in favour of the collapse approach do not seem very convincing to me. His only point in favour of collapse theories is that in GRW theory, 'continuous slightly non-linear dynamics' have been developed, which take account of both the Schrödinger dynamics and the collapse process during measurement. But as long as the details of such a theory are not presented and motivated, this can hardly convince. Such a 'slightly non-linear dynamics' might be just an artificial mathematical construction in order to glue two rather different mathematical functions together into one, which approximates them both to a sufficient degree. Mathematically, this is always possible. Note that in a similar way, it is always possible to glue two rather different kinds of objects together into one. For instance, view a 'pilot wave' just as 'one' entity, consisting of a wave together with a particle 'surfing' on it. Do we now have a progress in ontological sparsity? Certainly not. It might be similar in the case of the 'slightly lon-linear dynamics' of GRW theory.

The crucial point, I think, is a different one. In any of the above versions, the only reason why some *extra* entity – process or object – is introduced into quantum mechanics is to avoid inconsistency with the experience. Such a situation is *never* methodologically satisfying. It is a basic principle of scientific methodology that such ad hoc assumptions are not justified as long as they do not have some *independent* empirical confirmation, via some new empirical predictions which could not have been made without them. But *none* of the above theories has ever had such independent empirical confirmation. As long as this situation continues, it is hard to conceive a convincing way to decide between the several versions of the ad hoc assumptions involved in the interpretation of measurement in quantum mechanics.