WHY BE A DUALIST?

QUANTUM MECHANICS AND THE ‘CONSCIOUSNESS CAUSES COLLAPSE HYPOTHESIS’

Raoni Wohnrath Arroyo [1] Valdenor Brito Jr [2]

[1]Centre for Logic, Epistemology and the History of Science, University of Campinas.
Support: grant #2021/11381-1, São Paulo Research Foundation (FAPESP)

[2]Graduate Program in Philosophy, Federal University of Santa Catarina

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INTRODUCTION

DISCLAIMER: FROM NOW ON, THINGS WILL COLLAPSE

- QM is underdetermined by solutions to the measurement problem.
- One can choose voluntarily one (Chakravartty, 2017).

Figure 1: Our choice henceforth

SUMMARY

1. Parsons (1980): ontological completeness.
2. Arroyo and Arenhart (2019): CCCH.
    - Strong substance dualism.
3. Arroyo (2022): add completeness to the list.
4. **Bonus:** Matter $\overset{\textit{needs}}{\Longleftrightarrow}$ mind.
    - * Moderate dualism revamped?

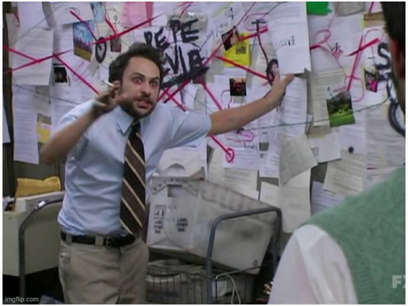

Figure 2: Plan of the talk

1. Completeness

INCOMPLETE OBJECTS

(Parsons, 1980, p. 19)

By calling an object 'complete,' I mean that for any nuclear property, the object has either that property or it has its negation.

- An incomplete object: does not possesses certain properties nor its negation.
- "[...] all existing objects are complete" (Parsons, 1980, p. 20).

Figure 3: Incomplete objects

INCOMPLETE OBJECTS

- Add to the Gold Mountain the property of (say) “being-located-in-Brazil” and “not-being-located-in-Brazil”.
- It wouldn’t change a thing.
- Pace Parsons (1980), such is an incomplete object regarding its location in Brazil.
- What about “having-spin-up” and “not-having-spin-up”?

Figure 4: The Gold Mountain?

2. A-level SQM

TEXTBOOK INDISTINGUISHABILITY

- All electrons have the state-independent properties:
- Rest mass ($0.511 MeV$).
- Electric charge ($-1.6 \times 10^{-19} C$).
- Spin ($\frac{1}{2}\hbar$).

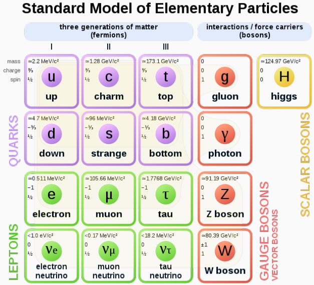

Figure 5: Not making things up (nor down)!

TWO EVOLUTIONS: STATE-*DEPENDENT* PROPERTIES

- Standard Q-M descriptions are deterministic and probabilistic.

$$|\psi_{t=0}\rangle = \Big(\alpha|z_{\text{UP}}\rangle_e + \beta|z_{\text{DOWN}}\rangle_e\Big) \otimes |\text{reset}\rangle_d$$

$$\downarrow$$

$$|\psi_{>0}\rangle = \alpha\Big(|z_{\text{UP}}\rangle_e \otimes |\text{UP}\rangle_d\Big) + \beta\Big(|z_{\text{DOWN}}\rangle_e \otimes |\text{DOWN}\rangle_d\Big)$$

$$|\alpha|^2 + |\beta|^2 = 1$$

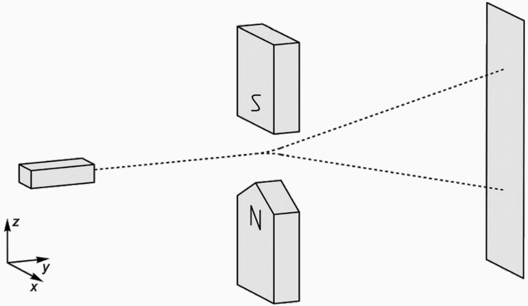

Figure 6: Stern–Gerlach-experiment

LACK OF A PHYSICAL REPRESENTATION

It is, however, hard to appreciate what kind of macroscopic state the sum of measuring states $|\text{UP}\rangle_d + |\text{DOWN}\rangle_d$ may represent.

Figure 7: Not superposed?

AN ARBITRARY CUT

- Dirac (1930): only unique measurement results count as measurement outcomes.
- When? Bohr (1928, p. 102): interaction with a macroscopic system.
- Pauli (1950): "Heisenberg's cut".
- von Neumann (1932): the "cut" is arbitrary, i.e. it could be placed anywhere between quantum systems and the observer's brain.

Figure 8: Let's cut

VON NEUMANN'S CHAIN

Let's put the retina and the brain into the scene:

$$\mathscr{H} = \mathscr{H}_e \otimes \mathscr{H}_d \otimes \mathscr{H}_n \otimes \mathscr{H}_b$$

$$|\psi\rangle = \alpha\Big(|z_{\mathrm{UP}}\rangle_e \otimes |\mathrm{UP}\rangle_d \otimes |\mathrm{UP}\rangle_n \otimes |\mathrm{UP}\rangle_b\Big) + \beta\Big(|z_{\mathrm{DOWN}}\rangle_e \otimes |\mathrm{DOWN}\rangle_d \otimes |\mathrm{DOWN}\rangle_n \otimes |\mathrm{DOWN}\rangle_b\Big)$$

VON NEUMANN'S CHAIN

(Baggott, 1992, p. 186)

Quantum particles are known to obey the laws of quantum theory: they are described routinely in terms of superpositions of the measurement eigenstates of devices designed to detect them. Those devices are themselves composed of quantum particles and should, in principle, behave similarly. This leads us to the presumption that linear superpositions of macroscopically different states of measuring devices (different pointer positions, for example) are possible. But the observer never actually sees such superpositions.

BREAK THE CHAIN!

- The abstract ego collapses the situation into UP or DOWN, up to probability (von Neumann, 1932).
- Abstract ego = mind (Wigner, 1983).
- de Barros and Montemayor (2019) and de Barros and Oas (2017) coined the term “Consciousness Causes Collapse Hypothesis (CCCH)”.
- We’ll leave London and Bauer (1939) out. For discussion, see French (2002, 2020), Arroyo and Nunes Filho (2018), and Arroyo and Arenhart (2020).

A CARTESIAN CUT

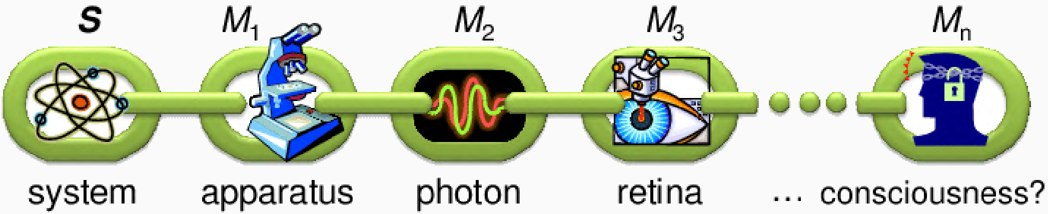

Figure 9: von Neumann's chain (Piani and Adesso, 2012)

METAPHYSICAL CONSTRAINTS FOR SCIENTIFIC ONTOLOGIES

Arroyo and Arenhart (2019, p. 37): this ontological commitment with the existence of mind demands metaphysical constraints:

- *Causality:* mind must act upon matter;
- *Transcendence:* mind is not reducible to matter;
- *Interaction:* mind must interact with matter.

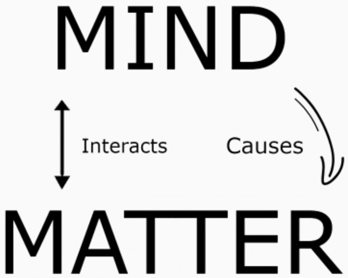

Figure 10: Mind over matter

THE METAMETAPHYSICAL CONSTRAINTS: RULING OUT MODERATE DUALISM

Arroyo and Arenhart (2019, pp. 37-38):

- Strong substance dualism: The mental stuff is immaterial, and its properties are distinct and exist independently of the material stuff;
- Moderate substance dualism: The mental stuff is immaterial, and its properties are distinct, but its existence depends on the material stuff.

(Arroyo and Arenhart, 2019, p. 38)

[...] if the very existence of a substance, say, mental, is dependent of the material, then consciousness would not be able to act as a causal agent in the measuring process of QM; and the other way around would not be compatible as well, because the mind alone could not create a result of a quantum measurement—its causal power is strictly dependent of the experimental setup in which the quantum system lies in.

RAONI DEFENDED THIS VIEW ELSEWHERE

R. W. Arroyo and J. R. B. Arenhart (2019), "Between physics and metaphysics: A discussion of the status of mind in quantum mechanics", in Quanta and Mind, ed. by J. A. de Barros and C. Montemayor, Synthese Library, Springer, Cham, pp. 31-42, DOI: *10.1007/978-3-030-21908-6_3*.

R. W. Arroyo (2020), Discussions on physics, metaphysics and metametaphysics: Interpreting QM, PhD thesis, Federal University of Santa Catarina (UFSC), Florianópolis, *https://tede.ufsc.br/teses/PFIL0381-T.pdf*, Chap. 5, 7.

J. R. B. Arenhart and R. W. Arroyo (2021), "On physics, metaphysics, and metametaphysics", Metaphilosophy, 52, 2, pp. 175-199, DOI: *10.1111/meta.12486*.

3. K–S theorem

METAPHYSICAL IMPLICATIONS OF THE K–S THEOREM I

(Zeilinger, 2005, p. 743)

[...] even for single particles, it is not always possible to assign definite measurement outcomes independently of and prior to the selection of specific measurement apparatus in the specific experiment.

METAPHYSICAL IMPLICATIONS OF THE K–S THEOREM II

(da Costa, 2019, p. 75, emphasis added)

The results observed in measurement are dependent upon what other measurements are being made; in other words, the result of a measurement of an observable is dependent on which other commutating observables are being measured. (Quantum contextuality means that the result of a measurement of a quantum observable is dependent on which other commuting observables are being regarded.) [...] <u>each observable of a quantum system should have a well-defined value in any instant of time, what is false according to the theorem.</u>

METAPHYSICAL IMPLICATIONS OF THE K–S THEOREM III

(de Barros and Montemayor, 2019, p. 57, emphasis added)

It so happens that the idea that a superposition is a state with either one property or the other is not consistent. So, a measurement does not reveal the existing value of a property, but seems to create it.

METAPHYSICAL IMPLICATIONS OF THE K–S THEOREM IV

(Baradad, 2022, p. 1044)

[...] the ineliminable contextuality of measurement; or to put it another way, the downfall of the metaphysics of individualism (the assumption that there are pre-existing individuals with a full set of determinate properties).

METAPHYSICAL IMPLICATIONS OF THE K–S THEOREM I

Leggett (1991, p. 87)

> [...] it is the act of measurement that is the bridge between the microworld, which does not by itself possess definite properties, and the macroworld, which does.

K–S AND ONTOLOGICAL COMPLETENESS

K–S theorem: *quantum objects are incomplete objects up to contextuality/measurement contexts*

That is to say that it is due to the act of measurement (which, to CCCH, is caused by the observer's mind) that quantum objects acquire completeness in a metaphysical sense.

ANOTHER METAPHYSICAL CONSTRAINT FOR CCCH'S MIND

- Parsons (1980): prior to measurement contexts, quantum objects does not possesses the property of having a spin value of UP nor ¬UP (i.e. DOWN).
- They are *incomplete objects* with regards to state-dependent/context-dependent properties (such as spin, position, momentum).

Completeness. It is due to the causal interaction with the transcendent mind that quantum objects acquire completeness; otherwise, their state-dependent/context-dependent properties are non-existent.

RAONI DEFENDED THIS VIEW ELSEWHERE

R. W. Arroyo (2022), “The Kochen–Specker theorem and ontological (in)completeness of quantum objects”, CLE e-Prints, 20, 1.

TO DO: VALDENOR AND BENNETT (2017) FOR THE HELP?

Matter needs the mind to acquire completeness.

Mind is needed so matter have completeness.

Is there a symmetry of ontological dependence on both sides of dualism?

If so, moderate dualism can be revamped within CCCH.

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Thanks!

rwarroyo@unicamp.br

valdenormb@hotmail.com