

Quantum Considerations in the Metaphysics of Levels

The unity of science is often taken to depend on the ontological relationship of different levels of reality,¹ but Amie Thomasson challenges advocates of any such layered conception to answer “how layers are distinguished” and “what holds them together” by “examining the world.”² One strategy for answering such questions is mereological, treating inter-layer relations as parthood relations, where natural kinds are part of adjoining levels when objects of one natural kind are immediate proper parts composing an object of another natural kind. The hierarchy thus presented may be only partial rather than smooth, but the anti-symmetry of parthood guarantees a distinction between layers. Layers will exist whenever composition does, and the number of layers will be equivalent to the number of answers to Peter Van Inwagen’s Special Composition Question (SCQ), while answers to his General Composition Question (GCQ) explain what holds the layers together.³

Attempts to examine the world have led to various hypothesized answers for these questions. One popular conclusion, held by Richard Feynman, Hilary Putnam, and Kit Fine is that the universe is obviously atomic, with the particles of physics at its fundamental level, and no real differences among the higher levels.⁴ If only the atoms are fundamental in the ontology, however, then this answer allies neatly with Composition-as-Identity,⁵ giving a universalist answer to the SCQ and a logicist answer to the GCQ, and yielding an expansive hierarchy of levels but a deflationary ontology.⁶ If the universe is gunky rather than atomic, then there would be no fundamental level, but the expansionary hierarchy and deflationary ontology remain.⁷ Even Jonathan Schaffer’s later view that the universe as a whole is the fundamental layer suggests a deflationary ontology where the number and relation of the layers has little metaphysical importance.⁸

A very different answer is given by Van Inwagen himself, who suggests that there are only two layers, physical particles and biological organisms, and that both are equally fundamental, with

¹ Much of the contemporary discussion began with J. A. Fodor, “Special Sciences (or: The Disunity of Science as a Working Hypothesis),” *Synthese* 28, no. 2 (1974): 97–115, <https://doi.org/10.1007/BF00485230>.

² Amie L. Thomasson, “It’s a Jumble out There: How Talk of Levels Leads Us Astray,” *American Philosophical Quarterly* 51, no. 4 (2014): 287.

³ Namely, “when does composition occur?” and “what is composition,” respectively: Peter van Inwagen, “When Are Objects Parts?,” *Philosophical Perspectives* 1 (1987): 24, <https://doi.org/10.2307/2214142>; as Katherine Hawley, “Principles of Composition and Criteria of Identity,” *Australasian Journal of Philosophy* 84, no. 4 (December 2006): 481–93, <https://doi.org/10.1080/00048400601078955> explains, answers to these questions may be disjunctive.

⁴ Richard P. Feynman, Robert B. Leighton, and Matthew Sands, *The Feynman Lectures on Physics: Mainly Mechanics, Radiation, and Heat*, New Millennium Ed., vol. 1 (Basic Books, 2015), sec. 1.2; Paul Oppenheim and Hilary Putnam, “Unity of Science as a Working Hypothesis,” in *Concepts, Theories, and the Mind-Body Problem*, Minnesota Studies in the Philosophy of Science 2 (Minneapolis: University of Minnesota Press, 1958), 3–36, <http://conservancy.umn.edu/handle/11299/184622>; Kit Fine, “Aristotle on Matter,” *Mind* 101, no. 401 (1992): 35–57.

⁵ Whether in its strong version due to Donald L. M. Baxter, “Many-One Identity,” *Philosophical Papers* 17, no. 3 (November 1, 1988): 193–216, <https://doi.org/10.1080/05568648809506300>; or in its weaker version due to David K. Lewis, *Parts of Classes*, ed. John P. Burgess (B. Blackwell, 1991).

⁶ I take this to be why Jaegwon Kim, “The Layered Model: Metaphysical Considerations,” *Philosophical Explorations* 5, no. 1 (January 1, 2002): 2–20, <https://doi.org/10.1080/10002002018538719> finds the question of levels crucial for emergentists but irrelevant for reductionists:

⁷ Jonathan Schaffer, “Is There a Fundamental Level?,” *Noûs* 37, no. 3 (2003): 498–517, <https://doi.org/10.1111/1468-0068.00448>.

⁸ Jonathan Schaffer, “Monism: The Priority of the Whole,” *The Philosophical Review* 119, no. 1 (2010): 31–76.

composition occurring only when particles form an organism.⁹ While Van Inwagen gave no answer to the GCQ (nor a mereology apart from his opposition to universal fusion), Rob Koons proposed a GCQ answer and corresponding mereology consonant with Van Inwagen's answer to the SCQ, suggesting that the physical parts of an organism are synchronically grounded in the whole while the existence of the biological whole is diachronically grounded in its physical parts.¹⁰

While all of the aforementioned proposals are intended to be compatible with (and often motivated by) contemporary science, none seem to take explicit account of different interpretations of quantum theory. Some answers, however, are explicitly motivated by the difficulties of interpreting quantum mechanics. Tim Maudlin has proposed a three-layered hierarchy, with a "flash ontology" that includes universe-spanning fields, point particles with momentary existence, and ensembles of entangled particles that may be identified with organic or inorganic structures.¹¹ Koons has more recently offered a somewhat different two-layer answer, comprised of "thermal substances" which are identified by the commuting classical properties of quantum algebras, and their entangled particle parts, modeled at the continuum limit.¹² I have previously given a mereology consonant with this proposal.¹³

In this PhD project, I seek to meet Thomasson's challenge by identifying which of these proposals best comports with our understanding of physics. There are two sources of constraints for this project. First, some proposals may only be compatible with certain interpretations of quantum mechanics, and not all interpretations are equally plausible. We should favor those proposals which are compatible with the broadest range of likely interpretations. For example, Claudio Calosi points out that Schaffer's monism is not indifferent among interpretations of quantum mechanics,¹⁴ and Koons briefly alleges that it is only compatible with no-collapse theories.¹⁵ Similarly, answers which posit a fundamental layer made up of distinct particles may only be compatible with pilot-wave interpretations, and may in fact pose even sharper conflicts with relativity than pilot wave theories already face.¹⁶ Maudlin's theory, meanwhile, relies not only on an objective-collapse interpretation of quantum mechanics but on entanglement generally being broad enough to correlate with macroscopic effects, yet narrow enough that experimenters can be separated from apparatus and experiments run independently. Koons' current view demands that entangled overlapping parts not prevent objects from behaving as classically separate. All of these assumptions are worthy of interrogation.

Second, Maudlin points out that our ontology must be compatible with *some* coherent interpretation of quantum mechanics.¹⁷ Schaffer's holism may be most compatible with many-

⁹ Peter van Inwagen, *Material Beings* (Ithaca, NY: Cornell University Press, 1995).

¹⁰ Robert C. Koons, "Staunch vs. Faint-Hearted Hylomorphism: Toward an Aristotelian Account of Composition," *Res Philosophica* 91, no. 2 (April 2014): 151–77.

¹¹ Tim Maudlin, *Quantum Non-Locality and Relativity: Metaphysical Intimations of Modern Physics*, 3rd ed (Malden, MA: Wiley-Blackwell, 2011).

¹² Robert C. Koons, "Thermal Substances: A Neo-Aristotelian Ontology of the Quantum World," *Synthese*, July 15, 2019, <https://doi.org/10.1007/s11229-019-02318-2>.

¹³ Ryan Miller, "Not Another Brick in the Wall: An Extensional Mereology for Potential Parts" (preprint, 2020), <http://philsci-archive.pitt.edu/17076/>.

¹⁴ Claudio Calosi, "Quantum Monism: An Assessment," *Philosophical Studies* 175, no. 12 (December 2018): 3217–36, <https://doi.org/10.1007/s11098-017-1002-6>.

¹⁵ Koons, "Thermal Substances."

¹⁶ For the difficulties of reconciling pilot-wave theories with relativity, see Maudlin, *Quantum Non-Locality and Relativity*. These theories may compound those difficulties because particle numbers are not invariant across reference frames, while these classical mereologies assumes that fusions have determinate parts.

¹⁷ *Ibid.*

worlds interpretations, but the many-worlds interpretation probably requires infinite distinct minds in order to yield the correct probabilities, and such minds do not enter into super-positions,¹⁸ so they would not be part of Schaffer's universe. Perhaps Schaffer's monism, inspired by quantum mechanics, is not fully compatible with *any* of its plausible interpretations. Van Inwagen's view may also run afoul of Maudlin's heuristic, since without inorganic composition and undetached parthood, there is no plausible way of describing the laboratory equipment which reveals the existence of particles and their behavior. Paraphrasing can render the manifest image into a scientific image, but here Van Inwagen denies essential elements of the scientific image. Without classically-behaving inorganic objects, we cannot interpret quantum mechanics.

In short, quantum mechanics gives us good reason to reject many answers to the specific and general composition questions, and their associated theories of ontological layers, which do not take account of its interpretation. Answers which do take account of quantum mechanics, however, make potentially testable claims about the scope of entanglement. By examining the world, we can learn a great deal about how layers are distinguished and what holds them together.

¹⁸ David Z. Albert, *Quantum Mechanics and Experience* (Cambridge, Mass: Harvard University Press, 1992).