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Université de Genève

# The Philosophy and Metaphysics of Particles

SE, A, ME 12-14, L208
Modules: MA6, MA7, MA8

**Schedule** (readings marked with an asterisk (*) are optional background readings):

17.09. Introduction to the seminar and the topic (MN and CW)

*Part 1: Particles in Quantum Mechanics*

24.09. Introduction to quantum mechanics (MN)

Lewis, P. (2016), "Phenomena and Theory", in *Quantum Ontology: A Guide to the Metaphysics of Quantum Mechanics* (Chapter 1). Oxford University Press.

*Ismael, J. (2025), "Quantum Mechanics", in *Stanford Encyclopedia of Philosophy.* https://plato.stanford.edu/entries/qm/.

01.10. Allori, V. (2013), "Primitive Ontology and the Structure of Fundamental Physical Theories", in *The Wave Function: Essays on the Metaphysics of Quantum Mechanics* (Ed. Ney, A. and Albert, D.). Oxford University Press.

*Lewis, P. (2016), "Underdetermination", in *Quantum Ontology: A Guide to the Metaphysics of Quantum Mechanics* (Chapter 3). Oxford University Press.

08.10. Calosi, C. and Wilson, J. (2021), "Quantum indeterminacy and the double-slit experiment". *Philosophical Studies* 178 (10):3291-3317.

15.10. Calosi, C. and Morganti, M. (2021), "Interpreting Quantum Entanglement: Steps towards Coherentist Quantum Mechanics". *British Journal for the Philosophy of Science* 72 (3):865-891.

*Schaffer, J. (2010), "Monism: The Priority of the Whole". *Philosophical Review* 119 (1):31-67.

22.10. Dieks, D. and Lubberdink, A. (2022), "Identical quantum particles as distinguishable objects". *Journal for General Philosophy of Science* 53 (3):259-274.

*French, S. and Bigaj, T. (2024), "Identity and Individuality in Quantum Theory", in *Stanford Encyclopedia of Philosophy.* https://plato.stanford.edu/entries/qt-idind/.

29.10. Redhead, M. and Teller, P. (1992), "Particles, Particle, Labels, and Quanta: The Toll of Unacknowledged Metaphysics". *Foundations of Physics* 21 (1):43-62.

*Teller, P. (1994), "From Particles to Quanta", in *An Interpretive Introduction to Quantum Field Theory* (Chapter 2). Princeton University Press.

05.11. No session (semaine de lecture)

12.11. Pashby, T. (2016), “How Do Things Persist? Location Relations in Physics and the Metaphysics of Persistence” (Sections 1-5.1). *Dialectica* 70 (3):269-309.

*Part 2: Particles in Quantum Field Theory*

19.11. Introduction to quantum field theory (MN)

Kuhlmann, M. and Lyre, H. and Wayne, A. (2002), “A Layperson’s Guide to QFT” in *Ontological Aspects of Quantum Field Theory* (Sections 1.2 and 1.3). Singapore: World Scientific.

Kuhlmann, M. (2010), “History and Basic Structure of QFT” in *The Ultimate Constituents of the Material World: In Search of an Ontology for Fundamental Physics* (Chapters 4 and 5). De Gruyter.

26.11. Fraser, D. (2022), “Particles in quantum field theory” in *The Routledge Companion to Philosophy of Physics* (Ed. Knox, E. and Wilson, A.) (Chapter 21). Routledge.

*Baker, D. (2015), “The Philosophy of Quantum Field Theory” (Sections 1-3), in *The Oxford Handbook of Topics in Philosophy*. Oxford University Press.

03.12. Fox, T. (2008), “Haunted by the Spectre of Virtual Particles: A Philosophical Reconsideration”. *Journal for General Philosophy of Science* 39 (1):35-51.

10.12. Kuhlmann, M. (2010), “Dispositional Trope Ontology” in *The Ultimate Constituents of the Material World: In Search of an Ontology for Fundamental Physics* (Chapter 13). De Gruyter.

*Morganti, M. (2009), “Tropes and Physics”. *Grazer Philosophische Studien* 78 (1):185–205.

17.12. Baker, D. (2009), “Against Field Interpretations of Quantum Field Theory”. *The British Journal for the Philosophy of Science* 16 (3):585-609.

*Teller, P. (1990), “What the Quantum Field is Not’’. *Philosophical Topics* 18 (2):175-186.

**Course description**

This seminar explores the philosophical and metaphysical puzzles surrounding particles in modern physics. Although particles play a central role in theories from classical mechanics to the Standard Model, their ontological status remains deeply contested. Are they real entities, idealisations, or just useful fictions?

This course offers a rigorous entry point into the intersection of metaphysics and the philosophy of physics, equipping students to critically analyse one of the most basic—and most puzzling—elements of the physical world.

Through a combination of lectures and seminar discussions, students will examine how the concept of a particle shifts across classical physics and quantum theory. These developments will serve as a lens for broader questions in metaphysics and the philosophy of science, drawing on both historical sources and contemporary debates. This seminar deals with issues at the intersection between philosophy of physics and metaphysics as seen through the lens of particles in modern physics. Topics include scientific realism, observation, idealisation, identity, individuality, localisation, and persistence in both classical and quantum contexts.

No prior background in physics or philosophy is presupposed, although familiarity with the metaphysics of science will be beneficial. Basic ideas from quantum theory will be introduced as needed. The seminar will be conducted entirely in English and will include both introductory lectures and student presentations.

**Course requirements**

For credit in philosophy (contact us if you need credit in another program):

- *MA6:* written research paper with defence (approx. 25 pages, 50'000 characters)
- *MA7:* written research paper (approx. 12 pages, 24'000 characters) and oral presentation during the seminar
- *MA8:* written research paper (approx. 12 pages, 24'000 characters) or oral presentation during the seminar

Our expectation is that everyone prepares the assigned readings ahead of time, actively participates in the seminar (including those featuring a guest speaker), and accepts a reasonable share of presentation duties.

**Seminar presentations**

We expect everyone to do a brief presentation on one of the assigned readings. When it is your turn, please keep the following points in mind:

- While you will be the leader for the entire seminar on this day, including the discussion, the initial presentation should last (if given in one piece) about 15 to 20 minutes.
- Therefore, it is important to stick to the main points, the author's *main thesis* and their *main argument*, rather than to give a complete or chronological list of points raised in the article.
- We encourage you to use some *visual complement* (blackboard, powerpoint slides, handout), and to see this seminar as an opportunity to experiment with a format you have not yet tried.
- Make sure to read the article sufficiently ahead of time, so that we have time to make an appointment if you want to meet and discuss it before your presentation.
- Don't stress out if there is something in the article you don't understand after having made an effort to grasp it. In this case, try to articulate precisely what it is that you don't understand—and it may well become the topic of our seminar discussion.

**AI policy**

In its Statement on artificial intelligence, the University of Geneva clearly states that

> In their scientific publications and creations, researchers and students are required to respect the rules and principles governing scientific integrity, in particular the prohibition of plagiarism, and to comply with good scientific practice.

This good scientific practice demands that the use of generative AI "must always be explicitly agreed upon with the research supervisor and must be methodologically describable" (Guidebook on Generative Artificial Intelligence, p. 14) because they "raise issues of plagiarism" (ibid.). Hence, "[w]riting tasks should not be delegated to the tool" (ibid.). In other words, it is **impermissible** to use generative artificial intelligence such as ChatGPT in the writing of seminar papers or theses, although other uses may be permissible if agreed upon with us beforehand.