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Département de philosophie
Université de Genève

Philosophy of Physics: Philosophy of Cosmology

SE, A, Je 16-18, SO 019
Modules: MA6, MA7, MA8

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

18.09. Introduction to the seminar and the topic (CZ and CW)

*Chris Smeenk and George Ellis (2017). Philosophy of Cosmology, *Stanford Encyclopedia of Philosophy*, https://plato.stanford.edu/entries/cosmology/

*Chris Smeenk (2014). Einstein's role in the creation of relativistic cosmology. In Michel Janssen and Christoph Lehner (eds.), *The Cambridge Companion to Einstein*. Cambridge University Press, pp. 228-269.

Part 1: The Standard Big Bang Model and its limits

25.09. Inflationary Cosmology (CZ)

*Alan H Guth (2000). Inflation and eternal inflation. *Physics Reports* 333-334: 555-574.

02.10. Casey D McCoy (2015). Does inflation solve the hot big bang model's fine-tuning problems?. *Studies in History and Philosophy of Science Part B: Studies in History and Philosophy of Modern Physics*, 51, 23-36.

09.10. Craig Callender (2004). Measures, explanations and the past: Should 'special' initial conditions be explained?. *The British Journal for the Philosophy of Science*, 55, 195-217.

16.10. Craig Callender and Casey D McCoy (2021). Time in cosmology. In *The Routledge Companion to Philosophy of Physics*. Routledge, pp. 707-718.

23.10. Siska De Baerdemaeker and Richard Dawid (2022). MOND and meta-empirical theory assessment. *Synthese*, 200, 344.

30.10. Michela Massimi (2018). Three problems about multi-scale modelling in cosmology. *Studies in History and Philosophy of Modern Physics*, 64, 26-38.

Siska De Baerdemaeker and Nora M Boyd (2020). Jump ship, shift gears, or just keep on chugging: Assessing the responses to tensions between theory and evidence in contemporary cosmology. *Studies in History and Philosophy of Modern Physics*, 72, 205-216.

06.11. No session (semaine de lecture)

Part 2: Issues in the Early Universe Cosmology

13.11. Chris Smeenk (2019). Gaining access to the early universe. In Radin Dardashti, Richard Dawid, and Karim Thébault (eds.), *Why trust a theory? Epistemology of Fundamental Physics.* Cambridge University Press, pp. 315-335.

20.11. Feraz Azhar and Jeremy Butterfield (2017). Scientific realism and primordial cosmology. In *The Routledge Handbook of Scientific Realism*. Routledge, pp. 304-320 (skip section 4).

27.11. David Wallace (2010). Gravity, entropy, and cosmology: in search of clarity. *The British Journal for the Philosophy of Science*, 61, 513-540.

Part 3: The Dark Side of Cosmology

04.12. Siska De Baerdemaeker (2021). Method-driven experiments and the search for dark matter. *Philosophy of Science*, 88, 124-144.

*Chris Smeenk and James O Weatherall (forthcoming). The aims and structure of cosmological theory, ch. 5: The Principles of Dynamics and the Dynamics of Evidence.

11.12. Chris Smeenk and James O Weatherall (forthcoming). The aims and structure of cosmological theory, ch. 6: Dark energy.

*Ruth Durrer (2011). What do we really know about dark energy?. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 369, 5102-5114.

18.12. Adam Koberinski and Chris Smeenk (2024). Philosophical issues in early universe cosmology. In *Oxford Research Encyclopedia of Physics*.

Course description

This seminar focuses on the philosophy of cosmology, which seeks to understand the conceptual foundations and methodological challenges involved in explaining features of the universe. Cosmology is often cashed out as the study of the largest-scale structure of the universe, as described by general relativity. From galaxies to black holes, cosmology strives to explain how these structures behave, how they have formed, and more broadly, to uncover the fundamental principles that govern the cosmos.

To fully address these aims, cosmology must also confront quantum physics. As we approach the big bang, the laws of relativity break down and quantum effects become more and more dominant. At even earlier times, a theory of quantum gravity becomes essential to explain the origin of the universe.

The philosophy of cosmology examines the conceptual and epistemological issues that arise in this context. This seminar will explore questions such as: How are cosmological theories developed and justified? What does it mean to test a theory that describes the entire universe? What role do fine-tuning arguments play in evaluating cosmological models? How do we

assess explanations that involve unobservable or speculative elements, such as inflationary theory or the multiverse?

While some background in physics, mathematics, and philosophy will be helpful, all necessary concepts will be introduced throughout the course. No specific knowledge beyond high school mathematics will be assumed. This seminar will be conducted entirely in English, though papers may be submitted in French if desired.

Course requirements

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

- *MA6 :* travail écrit de recherche avec soutenance (env. 25 pages, 50'000 signes)
- *MA7 :* travail écrit de recherche (env. 12 pages, 24'000 signes) et présentation orale durant le séminaire
- *MA8 :* travail écrit de recherche (env. 12 pages, 24'000 signes) ou présentation orale durant le séminaire

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.