AGPhil 10: Particle Physics 1

Time: Wednesday 15:00–16:30 Location: PTB SR AvHB

AGPhil 10.1 Wed 15:00 PTB SR AvHB

Towards a digital analysis of the concept of the virtual particle — •Adrian Wüthrich, Michael Zichert, and Arno Simons — Technische Universität Berlin

The concept of the virtual particle has been the object of lively debates concerning its ontological status and precise meaning of its associated terms. In the spirit of Wittgenstein, we start from the premise that the precise meaning of a term is determined by its use in a community of competent users. We also believe, in turn, that such use is best determined by analyzing as many instances as possible instead of only a few selected cases. Recent tools from the computational humanities have brought such comprehensive analyses within reach. Accordingly, in this talk, we discuss how some of these tools might help us determine the meanings of "virtual particle" and cognate terms on the basis of a large corpus of relevant texts. In particular we will present our preliminary results of a "semantic change detection" analysis. For this, we used contextualized word embeddings of occurrences of "virtual" in all articles of the relevant journals of the "Physical Review" family from 1924 to 2022.

AGPhil 10.2 Wed 15:30 PTB SR AvHB

On the emergence of virtual particles in classical mechanics — •Amaia Corral-Villate — University of the Basque Country, Spain

The indispensability of singular limits as a context for emergence has recently been questioned, but it is also known that they may entail the emergence of new properties in physics. Following this last idea, my objective in this talk is to build a very simple and illustrative model for emergence in classical mechanics, by analysing the singular limit consisting in taking the number of particles involved to be infinite.

Specifically, my model shows that under a general condition of locality, infinite classical mechanical systems may entail the emergence of entities that, given the similarities with virtual particles in quantum field theory, may be thought of as virtual particles in classical mechanics. Such similarities consist basically in (i) not satisfying the relation for energy and momentum, and (ii) belonging essentially to interactions.

Regardless of whether or not the basis for a model is itself physical, what can be learnt from it may help understand other processes that are physical. In particular, this simple and illustrative model of emergence in classical mechanics allows for a very intuitive grasp of the process of emergence of virtual particles itself, that can at the same time be analysed with clarity and precision.

AGPhil 10.3 Wed 16:00 PTB SR AvHB

A comparative computational analysis of epistemic markers in astrophysics and particle physics using contextualized word embeddings — •Arno Simons, Adrian Wüthrich, and Michael Zichert — Technische Universität Berlin, Berlin, Germany

We compare the different meanings and nuances of observation, experimentation and simulation in astrophysics and high-energy physics (HEP) over a 30-year period, spanning from 1992 to 2022. In particular, we use contextualized word embeddings trained on physics language to track semantic shifts in the meanings of these concepts in a corpus of over 600K physics articles from the arxiv preprint server. Our analysis is inspired, first, by recent empirical studies on the actual usage of epistemic concepts in science (Malaterre and Léonard 2023; Mizrahi 2022; Overton 2013) and, second, by ongoing debates in philosophy of physics on how astrophysics and HEP differ in their epistemic strategies, especially relating to the concepts we investigate (Ableson 2023; Karaca 2023; Jacquart 2022; Heidler 2017). In both these literatures, the meanings of concepts such as observation, experiment and simulation, are considered good indicators, or "markers", of the epistemic strategies used in different fields of physics or science more broadly. Despite our basic confidence in the fruitfulness of our computational and AI-based approach, we also critically discuss its applicability and its usefulness for the future of an empirical philosophy of science.