AGPhil 11: Philosophy of Particle Physics and Quantum Field Theory

Time: Friday 11:00–13:00 Location: HS XVII

AGPhil 11.1 Fri 11:00 HS XVII

From Data to Theory: Raw vs. Pre-Packaged Entities — •Nurida Boddenberg — University of Bonn, Bonn, Germany

In the philosophy of science, entities, whether objects, processes, events, or relations, are often interpreted literally as they appear in our theories. Even within a practice-oriented view of science, experimental findings are frequently assigned to specific entities, typically accompanied by a predefined framework of what those entities are assumed to represent.

In my talk, I will examine what can be inferred from experimental data. I introduce the term "raw entity" to describe entities whose properties are inferred directly from experimental data through causal reasoning, meeting criteria such as non-redundancy and empirical adequacy. In contrast, "pre-packaged entity" refers to entities tied to additional hypotheses or embedded within a theoretical framework, offering a ready-made interpretation but potentially incorporating non-empirical elements, such as theoretical assumptions unsupported by the experimental evidence.

To illustrate this distinction and explore whether meaningful "raw entities" exist, I will analyze three cases: the Cowan-Reines neutrino experiment (1956), often described as a direct detection of neutrinos; the Deep Inelastic Scattering (DIS) experiments of the 1960s, where partons, later identified as quarks and gluons, were the entities in question; and modern gravitational wave detections by the LIGO-Virgo collaboration.

AGPhil 11.2 Fri 11:30 HS XVII

Inconsistencies in Quantum Field Theories: Replacement vs. Refinement? — •Francisco Calderón — University of Michigan, Ann Arbor

The history of QFT is one of inconsistencies and attempts at overcoming them. Specifically, Blum*s history of QED (ms.) shows that it is one of inconsistencies in the UV. While it was known that QED also had divergences in the IR, IR problems are considered less pathological. Four decades after QED, it was discovered that soon-to-be QCD is asymptotically free. Although QCD also bore the worst of QED*s inconsistencies, the Landau pole, asymptotic freedom put worries about the consistency of QFT to rest. The only difference between QED*s and QCD*s Landau poles was that the former lies in the UV and the latter in the IR. Is there a historical explanation for this double standard? A common reaction to QED*s inconsistencies was to reject QFT altogether*call this attitude Replacement. A common reaction to QCD was that cleverer ways of looking at or extending RG techniques would prevent a catastrophe in the IR*call this attitude Refinement. One goal of my paper is to chart the history of asymptotic freedom, which is undertheorized from the point of view of QFTs (as opposed to a history of the discovery of quarks). Another goal is to compare my historical reconstruction of QCD with Blum*s of QED and draw some philosophical morals about the differences between Replacement and Refinement.

AGPhil 11.3 Fri 12:00 HS XVII

Deep Learning and Model Independence — •Martin King — MCMP, LMU Munich

Despite probing physics at unprecedented energies at the Large Hadron Collider, the Standard Model remains empirically adequate, though incomplete. The lack of evidence in favor of any new physics models means that the search for new physics beyond the Standard Model (BSM) is wide open, with no direction clearly more promising than any other. This marks a turn towards what are called 'model-independent' methods—strategies that reduce the influence of modelling assumptions by performing minimally-biased precision measurements, using effective field theories, or using Deep Learning methods (DL). In this paper, I present the novel and promising uses of DL as a primary tool in high energy physics research, highlighting the use of autoencoder networks and unsupervised learning methods. I advocate for the importance and usefulness of a philosophically substantial concept of model independence and propose a definition that recognizes that independence of models is not absolute, but comes in degrees.

AGPhil 11.4 Fri 12:30 HS XVII

Thermal qualification of the silicon detector modules for the Phase-2 upgrade of the CMS Outer Tracker — •Niyathikrishna Meenamthuruthil Radhakrishnan, Alexander Dierlamm, Ulrich Husemann, Markus Klute, Stefan Maier, Lea Stockmaier, Tobias Barvich, and Bernd Berger — Karlsruhe Institute of Technology, Karlsruhe, Germnay

The LHC is about to enter its high-luminosity era in 2029. In order to prepare the particle detectors to deal with the high particle rate and radiation damage, the detector components must be upgraded. One upgrade project is the replacement of the tracking system of the CMS detector. The new Outer Tracker will consist of two types of silicon sensor modules: 5592 PS modules which are made of one pixel sensor and one strip sensor and 7608 2S modules with two strip sensors.

Production and testing of these modules are carried out at 10 sites and one of the centers producing the 2S modules is KIT. In the tracker, these modules will be operated with a coolant temperature of around -35. It must be verified that the modules can function flawlessly at this temperature prior to installation in the detector. In order to do that, modules are placed inside a thermally insulated box with active cooling, called burn-in station, to perform temperature cycles and expose the modules to thermal stress for up to 48 hours. The electrical functionality of the modules is monitored during this period.

The talk will give a summary of the current status of the burn-in station at KIT and present the thermal qualification of the station as well as results with the first production modules.