Quantum Field Theory: Then & Now

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Center for Philosophy of Science

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"The Interplay of Theory and Experiment in Early High Energy Physics and the Transformation of the Notion of Particle"

In simplified accounts of scientific developments experiment and theory are often represented as playing clearly separate roles in the process of knowledge production. In such narratives of the history of particle physics, the experimenters' job was allegedly to discover particles, while the theorists' task was to classify them. In my presentation I would like to offer a more complex picture of this historical constellation, showing how the interplay of theory and experiment in high energy physics did not simply result in new knowledge about particles, but was actually a process in which the notion of particle was both a vague research object being slowly transformed and a flexible tool allowing to interpret and connect data of different kind.

Around 1920 physicists only counted two particles: the electron and the proton. The "light quantum", later better known as photon, was still a speculative and problematic construct with particle-like qualities which, since it was easily created and destroyed, could not be simply put in the same class as the fully stable electrons and protons. By 1954 the picture had changed, and physicists were confronted with a steady, increasingly multiform flow of micro-physical phenomena emerging from cosmic ray detection and accelerator experiments. These developments not only challenged the established particle classification based only on mass and charge, but even put into doubt what a particle should be taken to be. New questions arose: Were particle tracks seen in detectors evidence of new particles, or of excited states of already known ones? Could the same particle decay in different ways? Were the bumps (or "resonances") seen in the energy distribution of pion-proton scattering just signs of a stronger interaction between the pion and the proton, or were they indications of particles so short-lived that they never made it into a detector? And what about those particles which, like the neutrino and the antiproton, had long been postulated, but so far not detected?

Looking closer at some episodes of this historical process I will argue that the concept of particle was at the time in flow and, depending on the needs of the moment, could be represented by a formula, an acoustic or visual signal, a symbol, a series of quantum numbers, a position in a symmetry diagram, or a “Christian name”, as proposed in the recommendations for particle nomenclature issued in the early 1950s by a group of authoritative experimental physicists. Despite, or possibly thanks to, its vague character the notion of particle provided, and in many ways still provides, a fruitful heuristic tool shaping and bringing forward high energy physics research.

Anthony Duncan, University of Pittsburgh
"The Apparently Thermal Origins of Quantum Field Theory"

Abstract: TBA

Arthur Jaffe, Harvard University
TBA

Kerry McKenzie, University of California, San Diego
”What’s Essential to a Quantum Field"

`The Coleman-Gross theorem of QFT, which places significant constraints on the kind content of a fundamental quantum field theory, is arguably rich in metaphysical implications. In some of my work I’ve argued that it has profound implications for the viability of structuralism, for the nature of the dispute between Humeans and non-Humeans, and for the very concept of fundamentality itself.

Such big claims have (needless to say) been subject to numerous criticisms, and my assumptions as to what is essential to a quantum field has been a common theme among them. In this talk, I'll offer defences of the idea that respecting unitarity, having a certain group structure, and undergoing interaction are all essential features of quantum fields. While these defences will no doubt make controversial assumptions in turn, I hope to convey that there is at least something that is distinct and unique about trans-world theorizing within QFT.'

David Wallace, University of Southern California
TBA

Porter Williams, University of Southern California
"Julian Schwinger and The Audacity of Scope"

Abstract: TBA