Workshop: Establishing the Philosophy of Supersymmetry

Schedule

David Baker (University of Michigan)
What is a superfield?

Possible ontologies for supersymmetric quantum field theories are examined, including prospects for extending Everettian spacetime state realism and Bohmian primitive ontology approaches. I argue that the advantages of primitive ontology interpretations are lessened, since they must either lessen their ambitions vis a vis ontological clarity or abandon the explanatory advantages of superspace.

Agnese Bissi Uppsala University)
Supersymmetry in string theory

And the abstract is: In this talk, I will discuss the centrality of supersymmetry in string theory. In particular, I will focus on aspects related to holographic dualities and their geometrical realization.

Elena Castellani (University of Florence)
SUSY: the birth of an idea

The talk focuses on the rationale underlying the first developments of supersymmetry, from its first version as a world-sheet two-dimensional symmetry in early string theory to the 1974 seminal work of Wess and Zumino.

Radin Dardashti (University of Wuppertal)
Supersymmetry – The solution to (almost) all our problems?

The development of a scientific discipline is often framed as the continued confrontation of scientific theories with experimental data. This limited perspective on scientific theory development leads to a one-sided perspective on the assessment of scientific theories, where the continued commitment of the scientists, in spite of disconfirming empirical evidence, is sometimes considered irrational. A more complete analysis of the development of a scientific discipline needs to take into account the everyday practice of the scientists involved. This practice is to some extent determined by the scientific problems they are confronted with. The conceptual analysis of scientific problems and how they change, may therefore allow for a more fine-grained investigation of the development of a scientific discipline. In this talk I discuss what constitutes a scientific problem, what its elements are and how they change. I will then illustrate the advantages of a more problem-focused approach in understanding the development of and commitment to supersymmetry.

Richard Dawid (Stockholm University)
A Bayesian Perspective on the Search for Low Energy Supersymmetry

LHC experiments led to the discovery of a standard model-like Higgs particle but have not generated any empirical evidence for physics beyond the standard model. In particular, low energy supersymmetry (SUSY), which is considered a promising hypothesis for a number of reasons, has not found empirical support up to this point. How should the LHC results reasonably affect trust in low energy SUSY? The present paper aims to analyze this question by developing a Bayesian model of belief updating under the most relevant observations. The goal is not to come up with a specific quantification of the currently justified degree of trust in low energy SUSY. Rather, the paper aims to identify structures of reasoning and salient connections between prior assumptions and resulting degrees of trust. The analysis aims to play a significant role in assessing the pros and cons of future research strategies in experimental high energy physics. Philosophically, it aims to identify the epistemic element in deliberations on research strategies in an important case of contemporary scientific reasoning.

James Fraser (Durham University)
On the Epistemology of Infinite Quantum Systems

Philosophical work on quantum field theory has focused on the semantic question of how the physical content of a quantum theory with infinitely many degrees of freedom ought to be understood. This paper tackles the epistemological question of whether we have good reasons to believe that the world is described by such a theory. I consider two types of argument for thinking that we do: indispensability arguments, which appeal to the role that unitarily inequivalent Hilbert space representations play in accounting for physical phenomena like spontaneous symmetry breaking, and what I call an extrapolation argument, which supports the physical significance of the limit of infinite degrees of freedom by pointing to evidence for infinite volume cosmological models. Neither of these strategies turn out to be conclusive as they stand leaving the relevance of novel features of infinite quantum systems to real-world physics murky. I discuss ways of motivating foundational work on infinite quantum systems which do not turn on the representational veracity of these features and suggest that when it comes to the question of the epistemological status of unitarily inequivalent representations it will be important to consider other sources of non-uniqueness than the limit of infinite degrees of freedom.

Daniel Grimmer (University of Oxford)
The Pragmatic QFT Measurement Problem and the need for a Heisenberg-like Cut in QFT

Despite quantum theory's remarkable success at predicting the (statistical) results of experiments, many philosophers worry that it nonetheless lacks some crucial connection between theory and experiment. Such worries are at the root of the Quantum Measurement Problem. We can identify two kinds of worries: 1) pragmatic: it's unclear how to model our experiments so as to extract these predictions from the theory, and 2) realist: there is no realist narrative for the experiment which underlies these theoretical predictions. While both worries are interesting, the first is more severe. It is exactly this pragmatic theory-to-experiment link which provides evidential support and physicality to our theories. Without it, we are at risk of losing any right to claim evidential support (or worse physicality) for quantum theory. As I will discuss, these pragmatic worries are far worse in quantum field theory (QFT) than in non-relativistic quantum theory. Moreover, upon reflection, a satisfactory explanation of almost all of quantum theory's experimental successes unavoidably involves modeling

quantum fields. Thus, we really are at risk of losing any right to claim evidential support for large parts of quantum theory. Hence, I focus on the \textit{Pragmatic QFT Measurement Problem}.

But, what makes modeling measurements in QFT so hard? As I will discuss, attempts to naively transplant our non-relativistic quantum measurement theory into QFT are deeply unphysical and unsatisfying. Thus we need a new (or at least refined) measurement theory for QFT. However, as I will argue, aiming too directly at a new measurement theory is an incautious way to proceed and is apt to lead us astray. It is better to get at the root of things and begin from there. This paper proposes and carries out an alternate way forward: We ought to first better understand how our non-relativistic quantum measurement theory is rooted in notions of measurement chains and Heisenberg cuts. Then we ought to generalize these notions and transplant them into QFT. Finally, by reviewing the state of the art in the physics literature, we can see what measurement theory (if any) we are led to for QFT. Such a transplant is carried out in this paper. My analysis suggests the need for a pragmatic \textit{QFT-cut} analogous to the need for a pragmatic Heisenberg cut. Do physicists have good tools for crossing this QFT-cut? Are their tools collectively good enough to resecure evidential support for quantum theory? Is any individual tool wide-scoping enough to underwrite a measurement theory for QFT?

Martin King (University of Bonn)
Conjectures and Disconfirmations: The Standard Model and Minimal SUSY

One model in particular, the Higgs doublet of the Standard Model, is taken to have been confirmed by the Higgs boson discovery at the LHC, even though many models are compatible with the data. Some models, like the two-Higgs doublet model of minimal supersymmetry, provided even riskier predictions and could be argued as having been even more strongly confirmed by the discovery. This paper sketches an argument demonstrating this by comparing a Bayesian confirmation of the Standard Model Higgs with that of the Higgs in minimal supersymmetry. The paper then attempts to provide a way of understanding this result by modelling it as a case of eliminative induction.

Tushar Menon (University of Cambridge)
SUSY and the interpretation of symmetries

I discuss how considerations from supersymmetric field theories can play a role in justifying what Dasgupta calls the symmetry-to-(un)reality inference: if some mathematically well-defined quantity in a physical theory is found to be variant under (certain) symmetry transformations, then it does not correspond to a physically real quantity.

Michael Stöltzner (University of South Carolina)
Diagnosing demise? What empirical epistemology can say about supersymmetry

Sara Strandberg (Stockholm University)
Status of supersymmetry after LHC Run 2

The Run 2 of the LHC provided the experiments with a large set of proton-proton collision data that has been used to search for evidence of supersymmetric particles. Some Run-2 analyses are still ongoing, but many results have already been released. These are all consistent with the SM hypothesis, and the data have thus been used to set limits on parameters in various supersymmetric models. In this talk I will give an overview of this large body of results and discuss how they constrain the supersymmetric parameter space. I will also briefly discuss new possibilities in upcoming LHC runs and possible future colliders.

James Wells (University of Michigan)
Split Supersymmetry and Naturalness Tensions

Abstract: Even before the LHC began operation there were empirical and non-empirical reasons to support a form of supersymmetry that is much more massive than typical assumptions of low-energy supersymmetry. Those arguments are presented here, as well as the implications of these ideas for subsequent experimental probes of supersymmetry. The traditional notions of Naturalness are also discussed within the framework, clarifying tensions between Naturalness and other positive empirical and non-empirical assessments of the theory.