GP 2: History of Theoretical Physics

Time: Monday 16:15–18:15 Location: KH 02.019

GP 2.1 Mon 16:15 KH 02.019

The Young Bohr on the "Statistical": A Prelude to Quantum Indeterminacy — •Hajime Inaba — Meiji University, Tokyo, Japan — Niels Bohr Archive, University of Copenhagen, Denmark

This paper examines how and what Niels Bohr learned about the statistical approach in science during the 1900s, thereby illuminating his intellectual development during his student days. Despite the innovative work of James Clerk Maxwell and Josiah Willard Gibbs in the late nineteenth century, the word "statistical" still seems to have sounded peculiar in the context of physics at the beginning of the twentieth century. When Bohr enrolled at the University of Copenhagen in 1903, statistics, as discussed by Harald Westergaard, mainly concerned mass phenomena such as population, economy, and insurance. *Theory of Observation* by Thorvald Thiele, under whom Bohr studied mathematics, offered a mathematical theory of observational error illustrated by examples from population statistics. Harald Høffding, with whom Bohr had long been familiar, also discussed the relation between statistical laws and human behavior. In the context of physics, Bohr's doctoral dissertation on the theory of electrons in metals (1911) explicitly adopted Gibbs' theory of statistical mechanics. Bohr probably encountered it through a paper by Peter Debye, who emphasized the universality of Gibbs' method in that it depended only on the statistical properties of the constituents. This paper thus provides a backdrop for highlighting Bohr's later conception of the "statistical," which came to encompass indeterminacy in quantum mechanics.

GP 2.2 Mon 16:45 KH 02.019

From Virtual to Real. The Epistemological Relevance of Virtual Entities in (the Early History of) Quantum Field Theory — •Markus Ehberger — Deutsches Museum, München

The ontological, representational and epistemological status of virtual particles is still debated in the philosophy of physics. In the corresponding literature, the concept is nearly exclusively studied through its modern formulation. In this contribution, I will take a historically informed perspective on the virtual particle's role in scientific reasoning. By means of historical examples, I will identify an argumentative structure which utilizes the virtual particle concept - or concepts which we can reconstruct as lying in its historical trajectory. Such arguments are now part of scientific practice for nearly 100 years and, applying them, physicists took and take the ontological step from the virtual to the real. I will further argue that the appeal of reasoning with virtual particles and their prominence in the didactic literature is partially due to the storylines which could not be told without them. It is the narrative structure of the physical arguments and the virtual particle's role in them - both historically and contemporary -, which contributes to the concept's success.

GP 2.3 Mon 17:15 KH 02.019

On Textbooks and their Contexts during the Renaissance of General Relativity — •Bernadette Lessel — Philosophisches Institut, Universität Bonn

The Renaissance of General Relativity refers to the period from roughly 1955 to 1975, during which the field experienced significant institutional growth and conceptual advancements. The institutional growth came in the shape of the establishment of several research centers, each typically led by a senior principal investigator (PI) guiding a group of postdoctoral researchers and doctoral students, as is well documented in the work of Roberto Lalli, Jürgen Renn, and Alexander Blum. These centers acted as intellectual schools, where knowledge of general relativity was passed on to students, which was however channeled through the lens of the PI's particular research focus. A manifestation of this was the surge of publications of school-specific textbooks on general relativity. This talk examines the textbooks produced by three influential schools, analyzing how they reflect their unique research environments and their impact on subsequent generations of relativists: 1) The Hamburg group around Pascual Jordan, who aimed at an extension of general relativity to incorporate a variable gravitational constant. 2) The Paris group led by mathematician André Lichnerowicz, whose interest was the initial value problem in general relativity. 3) The Syracuse group around Peter Bergmann, who transitioned from unified field theory -collaborating initially with Albert Einstein- to concentrating on quantum gravity.

GP 2.4 Mon 17:45 KH 02.019

Foundations of quantum mechanics and the Milan School (1950s–1960s): conceptual issues and historical perspectives — •Luisa Lovisetti and Marco Giliberti — Department of Physics "Aldo Pontremoli", University of Milan, Milan, Italy

The Department of Physics at the University of Milan developed an early and distinctive interest in the conceptual and formal development of quantum mechanics, reflected in both its teaching programme and research activities. As early as the A.Y. 1926–27, lectures on matrix and wave mechanics were delivered by A. Pontremoli, making Milan one of the first Italian universities to introduce quantum mechanics into its curriculum. From the late 1950s onward, at a time when the pragmatic "Shut up and calculate" attitude was becoming increasingly dominant, a group of Milan-based physicists engaged deeply with foundational issues, contributing to the international debate on the foundations of quantum theory. A central role in this effort was played by G.M. Prosperi and his 1962 paper *Quantum Theory of Measurement and Ergodicity Conditions* (co-authored with A. Daneri and A. Loinger), which addressed the measurement problem within the conceptual framework developed by P. Jordan and G. Ludwig. The paper sparked a wide debate among leading physicists and also attracted significant attention from historians and philosophers of quantum theory. Drawing on the 1962 paper and subsequent responses, this presentation aims to illustrate a fundamental step of the historical development of the Milan School's foundational research and to explore its impact on the broader history of quantum mechanics.