Book review * of

Arne Schirrmacher. *Establishing Quantum Physics in Göttingen: David Hilbert, Max Born and Peter Debye in Context, 1900 - 1926.* IX + 120 pp., figs., appx.. Cham: Springer Nature, 2019 EUR 51.99 (paper); ISBN 9783030227272, e-book available

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The development of quantum physics began in 1900 with Max Planck's quantum hypothesis. In the following years, the growing number of contradictions between theory and new experimental observations attracted many scientists. The young mathematician Max Born, for example, became a physicist. David Hilbert, in 1911 an established and influential professor of mathematics at the age of 49, began teaching the new physics. During his teaching he developed new mathematical tools to address the quantum riddle. – Many historians of science feel attracted by the period from 1900 to 1926, when Max Born et al. introduced quantum mechanics (*Zur Quantenmechanik I & II* [Zeitschrift für Physik, 1925 & 1926]). Arne Schirrmacher has a sound knowledge of the relevant literature. He seems to be the first to analyse the various factors that led to the establishment of quantum physics in Göttingen. Particular local circumstances, local resources, and the research politics of the acting persons play an important role in this analysis. Thus, the text relies strongly on original documents (letters, memoranda etc) from various archives. Many of them are also given in their original German, in footnotes and in the appendix (pp. 95-106). Many readers would probably also welcome references to available English translations, e.g. Max Born's *Vorlesungen über Atommechanik* [Berlin,1925]; *The Mechanics of the Atom* [London, 1927].

The mathematician Felix Klein arrived at Göttingen in 1886, with excellent terms of employment. He had a major influence in the appointments of David Hilbert and others. Later Hilbert received many offers from other universities and used them to improve conditions in Göttingen even further. Also, they received additional funds

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from industry. At the institute there were especially many young people: students, others preparing for their *Habilitations-examen*, and *Privatdozenten* (akin to assistent professors). They all were particularly open to new ideas. – Physicists, on the other hand, struggled with limited resources. Eduard Riecke and Woldemar Voigt were the professors in physics. Both came to Göttingen around 1880. They closely cooperated with the mathematicians, who shared their funds with them. But funds for performing experiments were so meager that Voigt spent a considerable portion of his salary on laboratory equipment and other resources – even after 1906, when they got a new building. Thus it was extremely difficult to find excellent successors. These problems continued after their deaths, until 1920.

It was Hilbert who improved the situation. He invited visitors and guest professors, among them Henri Poincaré, Hendrik Lorentz, and Nils Bohr. Peter Debye was guest professor in 1914 and then stayed on as full professor. He established quantum physics in Göttingen through research and teaching. When he left in 1920, Max Born and James Franck became his successors.

Schirrmacher begins his book with a discussion of his contextual approach, interwoven with the contents of his book: it will be difficult to understand for readers who are not yet familiar with the contents. He identified several lines of development, which he discusses one after the other, in their historical contexts.

Then he analyses the opportunities offered by retirements and new positions for a new alignment of research areas and personnel in the years around 1915. Thus he discusses the changes in personnel of the chairs of physics and all neighboring fields (mathematics, astronomy, geophysics, technical physics, chemistry, and scientific philosophy) during the period 1905-1935. Lots of data! For a better overview he included two tables and a sketch, with Gustav Herglotz at a wrong place (p. 19).

Chapter 3 focusses on Hilbert and physics. Schirrmacher discusses the development of Hilbert's views on physics, his teaching, his assistants (mathematicians and physicists) and their salaries, his invitations to talks, the establishment of the guest professorship, and his influence on the changes in personnel also in the neighboring fields. This is accompanied by four tables and many documents. This chapter, and especially some of the letters in the appendix, are most interesting to everyone who wants to reflect on the relationship of mathematics to physics.

Then Schirrmacher discusses the research groups of Max Born in Berlin, Frankfurt, and Göttingen. He emphasizes that the experiment played a far greater role than previously recognized. Finally he suggests that 'after 1920 it was not the one golden road that led to a singular revolutionary achievement, but five avenues which [...] brought about matrix mechanics, [...] the statistical interpretation and more'. Thus 'the new quantum mechanics was the result of long-term groundbreaking work also in institutional terms'. (p.10)

The book has some annoying weaknesses. There are many typos (e.g. are/a, that/than, p.10; James Frank, Altbert Einstein p.109), and all kinds of errors in the German text, including incorrect hyphenations (e.g. let-zte, kritis-chen, p.8f). Also, there are lengthy sentences containing up to 83 words – without the appropriate punctuation (pp. 1f, 9). But the new view about the beginnings of quantum mechanics and the rich collection of documents make it worthwhile to study this book.