

Shaul Katzir, *The Beginnings of Piezoelectricity. A Study in Mundane Physics* (Dordrecht: Springer, 2007). 298 pp. hc. EUR 119.95. ISBN 978-1-4020-4669-8.

Piezoelectricity denotes the generation of electricity by mechanical strain in certain crystalline bodies, such as quartz and tourmaline. The 'direct' effect was discovered in 1880 by the brothers Jacques and Pierre Curie, who the following year also detected the 'converse' effect, namely the change in shape of a crystal if subjected to an applied electric voltage. The new phenomenon attracted a fair amount of interest, both among experimentalists and theorists, and it was eventually turned into a series of technologies, first and most importantly as resonators in quartz watches and similar time-keeping devices. However, Katzir's study of piezoelectricity is largely limited to the period 1880–1912, and for this reason he does not cover the later transition from pure science to technology. As he points out in his introduction, there has been a tendency among historians of 19th-century physics to focus on fundamental theories and concepts, such as those related to electromagnetism, atomic theory, and thermodynamics. The result is that many fields or subfields of a less glamorous nature have been either ignored or only dealt with inadequately. Piezoelectricity is an interesting example of such 'mundane physics', which may not only better represent what physicists worked with in the late 19th century, but also displays a historical trajectory different from, say, mechanics and electrodynamics. For example, there is not the slightest trace of the quantum and relativity revolutions to be found in the early development of piezoelectricity (nor were many others branches of physics affected). Although research in piezoelectricity was indeed mundane, it was neither dull nor unimaginative, and it attracted some of the period's most distinguished physicists, including C. W. Röntgen,

W. Thomson, W. Voigt, P. Duhem, and E. Riecke. As Katzir's detailed study documents, this example of mundane science involved intellectual challenges as well as intriguing practical problems.

The greatest merit of *The Beginnings of Piezoelectricity* is perhaps that it provides a detailed and meticulously documented history of a branch of physics, which hitherto has been almost totally ignored. It covers the discovery phase, the early experimental work and the attempts to understand the effect theoretically; the high point in theory was the phenomenological theory proposed in 1890 by the Göttingen physicist Woldemar Voigt, a complex and successful theory that is competently reviewed by Katzir. As he shows, Voigt's theory had the effect of turning a predominantly experimental field into one dominated by mathematical theory, the reason why he distinguishes between a pre-theoretical and a theoretical phase. Apart from this division in two parts, the book is largely chronologically structured. An appendix summarizes in the form of tables the major events in the history of piezoelectricity and the publications that made up the field. The discovery of the history of piezoelectricity is complicated by much earlier reports of electrification originating from pressure and also by the relation to pyroelectricity—electricity produced by heating crystals. The crystallographer René-Just Haüy observed as early as 1817 a form of electrification that has sometimes been claimed to be piezoelectricity, but Katzir argues that the claim is untenable. Pyroelectricity was a well-known phenomenon by 1880, and according to Katzir's reconstruction of the discovery of the Curie brothers it was closely related to their pyroelectric studies.

Although Katzir's book is very rich in details, it also contains more general and synthetic considerations that are of value to a fuller understanding of physics in the period from about 1880 to 1910. Thus, he uses piezoelectric research to discuss two different traditions of laboratory work, what has been called 'experimental physics' and 'measuring physics'. The latter tradition, which involved the study of the values of constants derived from mathematical

theory, came to dominate in Germany and in Voigt's Göttingen in particular (the monopoly of Göttingen physicists in post-1890 piezoelectric research is remarkable). Katzir further relates experimental physics to what he calls an 'artisanal approach' towards experimentation, whereas he sees measuring physics as closer to the approach in which data analysis and mathematical theory of instruments were given priority. As he points out, there is, in the history of piezoelectricity, an interesting national aspect, roughly that the shift from the early, pre-theoretical phase to the latter, theoretical phase was followed by a national shift from France to Germany. (The near absence of British physicists is another noteworthy feature.) It may be tempting to see in this shift, as well as in the different approaches to the study of piezoelectricity, an indication of different national styles of physics, but Katzir warns that the temptation should be resisted. There were indeed clear differences in style of experimentation, and also in conceptions of the proper theoretical framework, but he suggests that they were rather due to differences between various schools and traditions that were not tightly bound to either French or German styles of research.

Although Katzir discusses themes of interest in the context of philosophy of science, such as the theory–experiment interplay and various kinds of theoretical approaches (molecular, phenomenological, and thermodynamical), he keeps to the historical case of piezoelectricity and does not explicitly address philosophical issues. From this point of view it is a bit surprising that the book is published in the prestigious series Boston Studies in the Philosophy of Science (volume 246). Whether this is the reason or not, unfortunately the book is forbiddingly expensive. The prize of 120 Euros for less than 300 pages just does not seem reasonable. All the same, this is a welcome contribution to the history of modern physics, a masterly exposition of the development of piezoelectric research and a healthy antidote to the overemphasis on revolutionary theories that has characterized much of the literature in this branch of history of science.

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A Study in Mundane Physics

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