

Introduction

One way to get insight into the fascinating history of twentieth century physics and its inextricable entanglement with general history is to look at the life stories of particular individuals.¹ This book is a social-intellectual biography of the Belgian theoretical physicist, Léon Rosenfeld (1904–1974). In the history of science literature Rosenfeld is largely a blank sheet, but he was at the centre of modern physics as one of the pioneers of quantum field theory and quantum electrodynamics in the late 1920s and the 1930s. Today he is best known for his publications with Niels Bohr in 1933 and 1950 on measurability in quantum electrodynamics and as the fierce spokesman of Bohr’s complementarity interpretation of quantum mechanics after the Second World War.² Rosenfeld was, however, exceptionally erudite and made detailed and significant contributions across the whole range of theoretical physics, such as quantum field theory, nuclear physics, statistical physics, and astrophysics. In 1956, he founded the journal *Nuclear Physics*. Besides, he reflected deeply on the history and philosophy of science and its social role. During his career he held chairs at Liège, Utrecht, Manchester, and Copenhagen. He received the Francqui Prize in 1949, which is given exclusively to Belgian scientists and scholars, but in spite of its national character bestows an honour comparable to the Nobel Prize. In addition to his contributions to physics, Rosenfeld played a salient role as Bohr’s close

¹Söderqvist (2006), pp. 105–107. Hankins (1979).

²Rosenfeld’s political engagement as regards quantum epistemology and history of science has been treated in Jacobsen (2007; 2008). The scientific context of the famous Bohr–Rosenfeld paper has been discussed in Jacobsen (2011). Rosenfeld’s role in the quantum controversy has been treated in Freire Jr. (2001; 2005; 2007), and Rosenfeld’s contribution to constrained Hamilton dynamics has been dealt with by Salisbury (2006; 2007).

collaborator as well as communicator of Bohr's quantum philosophy. In their collaboration Rosenfeld was in charge of the mathematical formulations of their theoretical considerations, but he also served as a sounding board for Bohr, that is, a critical mind on whom Bohr could try out his ideas. Such a sounding board was of crucial importance for Bohr's way of working.

Rosenfeld was a perceptive, polyglot cosmopolitan, whose life crossed those of many important people in many countries; he was part of a ramified international scientific and scholarly network in both the East and West. He possessed a strong, integrated personality and was capable of performing exotic calculations at one moment, disentangling subtle philosophical questions, or intervening in a political discussion, the next — all at the highest level. He was also an eminent linguist; he mastered eight or nine languages, speaking and writing at least five of them fluently. To some he was regarded as a sage.³ He was kind, courteous, honest, decent, and upright, as well as shy, timid, and modest. He possessed a dry humour. Compared with the often boring and dull style of today's scientific publications which give the impression that science is an impersonal disembodied trade, Rosenfeld's publications are characterized by a rare erudition, originality, and personality. At the same time he insisted indefatigably and uncompromisingly on rigour, consistency, and logic in thought and argument. This strong commitment reveals temper and passion behind his shy appearance and it could make him rather biting and highly satirical in book reviews, polemical papers, not to mention private correspondence aimed at opponents of Bohr's complementarity interpretation or Marxists who blindly followed Stalin's decrees. Rosenfeld's vitriolic style was felt by many a "quantum dissident", that is, physicists who challenged the Copenhagen Interpretation of quantum mechanics from the 1950s onwards.⁴

As a Marxist, Rosenfeld fully recognized the political and social dimensions of scientific inquiry and took very seriously his

³Recollections of H. Levi (1993), NBA. Notes on L. Rosenfeld by S. Rozental, NBA. A. Bohr (1974). Møller (1974).

⁴Freire Jr. (2009).

responsibility as a scientist to speak out and challenge misinterpretations, as he saw them, of scientific concepts, in addition to working actively for socialism and peace. Rosenfeld was therefore actively involved in many controversies where scientific, philosophical, ideological, and political issues intersected. This makes the Rosenfeld Papers at the Niels Bohr Archive in Copenhagen a particularly valuable and rich source for exploring the development of modern physics in its ideological and political context. Rosenfeld clearly strove to combine his political interests with his views on science and this was relatively easy for him until the late 1940s. However, in the post-war years Rosenfeld's strong belief in a science driven by the researchers' curiosity rather than by state planning, and his conviction that philosophy should adapt to the novel achievements of modern science and not vice versa, could not be reconciled with the official communist conception of socialist scientific and scholarly work proper. He therefore sought to counter these new agendas. Rosenfeld's commitment seems to have been partly ignited and driven by the lessons he drew from his studies in the history of science. In the end, science will win over temporarily unfavorable receptions of new ideas. However, Rosenfeld was determined to defeat with stronger means than time the unfavorable reception of Bohr's complementarity among communist scientists and scholars and later among new generations of physicists.

The book is not a comprehensive biography of Rosenfeld. It does not treat Rosenfeld's research in its totality, and it deals only sporadically with his private life (for which there are only few sources). As reflected in the title, my motive has been to use the biography of Rosenfeld as a lens to study the intersection between physics, philosophy, and politics in the twentieth century. On the other hand, that focus makes sense *only* because it was such an integrate part of Rosenfeld's life. I have been driven by a strong curiosity and desire to understand Rosenfeld's world view, his activities and choices based on his convictions in physics and socialism, and to situate him within the historical, political, and scientific context, which *he* tried to understand and influence. The book therefore attempts to understand Rosenfeld and his activities in science and politics as

a whole.⁵ By following Rosenfeld's trajectory my book treats the intersection between Rosenfeld's science and politics in the different European cultures he lived in. Because of lack of sources documenting his specific activities and viewpoints at a given time, Rosenfeld's life sometimes takes the background in relation to events treated in the book rather than the focus. His views on scientific, philosophical, and political ideas come to the fore most clearly in the many controversies he engaged in. The study of these controversies provides new and relevant insights into, for example, the Cold War political debates and on the debates in the 1930s about quantum philosophy that have previously been overlooked or "black-boxed" for historical analysis or categorized in a stereotyped way.⁶ My undertaking involves furthermore depicting the scientific and scholarly community within which Rosenfeld operated and describing how his professional practice influenced his world view and vice versa. It also involves portraying the personal relationships that mattered most to Rosenfeld, and it shows how these conditioned, or sometimes conflicted with, his scientific and political commitments.⁷ In particular, the book revolves around the close friendship between Rosenfeld and Bohr. And since Rosenfeld was so strongly engaged in promoting Bohr's interpretation of quantum theory from the beginning of the 1930s, the book also constitutes a chapter of the story of the changing receptions of this influential, but also highly contested, point of view.

In the treatment of Rosenfeld and the controversies he took part in, scientific as well as political, I envision myself largely as a commentator illuminating and analyzing the issues at stake. My book is not a contribution to the defense of Bohr's interpretation of quantum mechanics, nor is it meant to defend Rosenfeld's support of Bohr

⁵To that extent the biography is existential in Thomas Söderqvist's meaning of the word. Söderqvist (1998), pp. 26–34. Among historical biographies of scientists employing a perspective similar to mine, see Cassidy (2005).

⁶In using a scientist less famous than, say, a Nobel laureate, as subject of a biography as well as analyzing scientific controversies with the aim of elucidating relevant themes, I have been inspired by the anthology Bertomeu-Sánchez and Nieto-Galan (2006). About scientific controversies, see for example Machamer *et al.* (2000).

⁷In writing about a leftist scientist, I have been inspired by Werskey (1988; 2007a).

and his criticism of quantum dissidents. On the other hand, I cannot claim to be completely neutral. Bohr used to say that “we are both onlookers and actors in the great drama of existence”, and that applies at least as much to the historical practice as to physics.⁸ Moreover, I fully sympathize with Rosenfeld in his criticism of the tendency, simply out of principle, to treat every scientific idea as equally true. Today there are many examples of how social, political, and ideological agendas, and the ever heavier political, industrial, and commercial focus on scientific products, interfere increasingly with sound scientific practice.⁹ Therefore there may even be a lesson to be drawn from Rosenfeld’s example with respect to the responsibility of scientists to speak out and challenge perverted scientific messages. Rosenfeld was intimately familiar with both Bohr’s quantum philosophy and Marxism, and this made him take action in order to demonstrate that an interpretation was possible that combined complementarity and dialectical materialism in the period beginning in 1947 when the Communist Party intensified its ideological grip on culture and science. Knowledge entails responsibility!

A biography of a scientist should deal with the science itself. According to Thomas L. Hankins, quantum mechanics “contains a large philosophical content which makes it a good subject for biographical treatment”.¹⁰ At the same time, Hankins stressed that the biographer of a theoretical physicist or a mathematician “will have difficulty adhering to the biographical form if he includes too many technical details”.¹¹ I have tried to keep this balance by giving a brief treatment of Rosenfeld’s early contributions to quantum field theory that form the background of his important work with Bohr and which also serve to motivate a few considerations about Rosenfeld’s style in physics. Bohr and Rosenfeld’s joint work is treated in its context of the controversies in the small community of theoretical physicists around Bohr in the early 1930s. To a theoretical physicist

⁸Bohr (1934), p. 119. See also Bohr (1999b), p. 60[76].

⁹See for example Oreskes and Conway (2010).

¹⁰Hankins (1979), p. 13.

¹¹*Ibid.*

my treatment may include too few technical details, whereas others may still find these sections difficult to read. I see no easy way around it. However, I hope the book conveys a lively, coherent, and faithful picture of the Rosenfeld I have come to know and have spent so much time with during the last seven years. The portrait reveals a complex life of a man who also experienced moral conflicts.

The book is divided into six chapters dealing chronologically with Rosenfeld's career, each representing a thematic episode and formed on the background of crucial events in world politics. The first chapter covers Rosenfeld's early career with a focus on the scholars and scientists he met, the physics that occupied him, and the scientific milieus he frequented. It includes briefly his education in Belgium and his subsequent route to becoming one of the foremost theoretical physicists at the time. This route went through Paris, where he was supervised by Louis de Broglie and Paul Langevin; to Göttingen where he was Max Born's assistant; to Zurich where around 1930 he matured as a physicist specializing in relativistic quantum mechanics under Wolfgang Pauli's guidance.

Chapter 2 deals with the early 1930s when Rosenfeld collaborated with Bohr in Copenhagen. Working part of each year in Copenhagen, Rosenfeld quickly adapted to the way physics was practiced at Bohr's institute. The collaboration between Bohr and Rosenfeld culminated in their paper of 1933, famous and notorious among physicists, on the measurability of quantum electrodynamics. The paper was an outcome of a controversy between mainly Bohr and Rosenfeld on the one hand and Lev Davidovich Landau and Rudolf Peierls on the other. However, other physicists such as Pauli also took part. The chapter illuminates the communication problems from which the physicists involved seem to have suffered. My aim is to provide the scientific and ideological context of its emergence and early reception. I hope I have succeeded in conveying the gist of the controversy of this highly academic subject. Bohr and Rosenfeld's collaboration took place parallel to Bohr's famous discussion with Albert Einstein about quantum epistemology, which culminated in 1935 when Einstein and his co-workers Boris Podolsky and Nathan Rosen confronted Bohr with the so-called EPR paradox in 1935. These two debates within the

physics community proved important for the clarification of Bohr's ideas on how to understand quantum theory.

Chapter 3 is concerned with illuminating the formation of Rosenfeld's leftist position and how in the 1930s he related his political outlook to science, philosophy, and history of science. However, since Rosenfeld has left only sporadic testimonies from that decade, the chapter brings to the foreground mainly the social and political contexts as Rosenfeld may have experienced them in terms of the appearance of extremist movements and political instability in Europe. Since Rosenfeld collaborated very closely with Bohr in the period, Bohr's activities are also given much attention. We learn about Bohr and Rosenfeld's visit to Russia in 1934 and about the effect of Hitler coming to power in 1933 on the life and work at Bohr's institute in Copenhagen. In particular the chapter relates how the political climate influenced the philosophical debates about Bohr's complementarity interpretation of quantum mechanics, when Bohr and his disciples attempted to communicate the epistemological lesson of quantum theory to an intellectual lay audience.

Not only was Rosenfeld a remarkable, many-sided physicist, he also lived through a historical period in Europe of exceptional violence and danger. Chapter 4 treats Rosenfeld's stay in Utrecht during the difficult times of German occupation. As an outspoken socialist possessing a name of Jewish origin, Rosenfeld was extremely vulnerable in a country invaded by Germany during the Second World War and he wisely kept a low profile. The questions to be addressed in this chapter are why Rosenfeld took up a position in Utrecht in the first place, how he managed the difficult times, and what his working conditions were like. Rosenfeld's correspondence, much of it in Danish, reveals hitherto unknown contact between physicists across the occupied countries. The documentation includes Rosenfeld's correspondence with Bohr and Christian Møller in Copenhagen, with Werner Heisenberg in Berlin, and with Oskar Klein in Sweden. Rosenfeld tackled the difficult times in Utrecht during German occupation by means of quiet courage and sanity, continuous contact in writing with his colleagues in Copenhagen, and by burying himself in work.

Chapter 5 covers the period 1945–1958, during which Rosenfeld spent first in Utrecht and from 1947 as a professor of theoretical physics in Manchester. It deals with the ethical and political dilemmas in which physicists found themselves after the Manhattan Project and the emerging Cold War atmosphere where the social responsibility of the scientist was highlighted. The chapter focuses on the basic concepts that Rosenfeld deployed in contests over the ideology and cultural values embodied by science in the early Cold War as well as on his political activism. As soon as the Second World War was over, he appeared optimistic that the time had come for uniting the Left in the creation of a better world based on reason, critical reflection, and socialism. He was a driving force in establishing the Dutch *Federation of Scientific Researchers* (VWO) and an active board member of the communist-led *World Federation of Scientific Workers*. He associated with, but was less active in, the *World Peace Congress*. Rosenfeld's alliance with the Left meant that he did not fully accept Bohr's idea that it would take an Open World, in which all information on technology, science, and social conditions was shared between nations, to prevent a catastrophic war with atomic weapons. Thus, Rosenfeld was simultaneously Bohr's strongest supporter in physics and his critic in politics. Even so, Rosenfeld's admiration for Bohr was undiminished. Bohr reciprocated the feelings and paved the way for Rosenfeld to take up a position as NORDITA professor in Copenhagen in 1958, at a time after Stalin's death when there was an opening for renewed contact and collaboration with Russian physicists.

The culmination of my treatment of the intersection between science and politics as seen through Rosenfeld is found in the final Chapter 6. It focuses on Rosenfeld's role as Bohr's spokesman and defender beginning in the late 1940s, when Cold War tensions framed controversies over the interpretation of quantum physics both in the East and in the West. Rosenfeld's defense of Bohr involved an outspoken critique of the turn in Russian domestic policy in matters of science and culture. I analyze Rosenfeld's view on the relation between science and philosophy and how it was in opposition to Marxism–Leninism. The chapter also treats Rosenfeld's bitter

controversy with the American physicist, David Bohm, and a group of young communist physicists in Paris, as well as the opposition his blending of dialectical materialism and complementarity met from the creators of quantum mechanics, Pauli, Born, and Heisenberg.

A brief epilogue about Rosenfeld's continued engagement in defending Bohr in the later years concludes the book. The style and attitude Rosenfeld adopted in this regard, was not always conducive to his evident intentions, *viz.*, to promote and elucidate Bohr's subtle views.