Chapter 19
Biography and the History of Science

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Abstract As a genre at the intersection of history and literature, biography challenges its writer to decide organizational rules and elements of plot that are faithful to the subject and attractive to the reader. Mary Jo Nye suggests that there are three principal forms of biography in which the subject is a scientist: the life of the scientist, the scientific life, and the life of scientific collaboration. She explains the meaning of these terms by drawing upon a range of recent biographies in modern science, including Kostas Gavroglu's biography of Fritz London.

Keywords Biography and history • Scientific life • Scientists' lives • Collaborative science • Fritz London • Robert Oppenheimer • Paul Dirac

19.1 Introduction

In an essay of 1939 Virginia Woolf asks the question whether biography is an art, and she answers—controversially, I would say—that it is not. The artist has a freedom that is denied to the biographer, she writes, because the biographer is constrained by verifiable facts, however few or however many the facts may be. In her words, "The novelist is free; the biographer is tied." The biographer does not have the license of creativity that is granted to the artist; "he is a craftsman . . . and his work is not a work of art, but something betwixt and between" (Woolf 1942, 188, 196).

By way of making her point, Woolf discusses the recent writings of Lytton Strachey and what she credits as a new biographical genre that departs from the "wax figures" and hagiography of Victorian lives and letters in favor of psychological portraits and intimate narrative. For Woolf, Strachey's experimentation in biography fails, however, in his portrayal of Queen Elizabeth in *Elizabeth and Essex: A Tragic History* (1928). Elizabeth "moves in an ambiguous world, between fact and fiction, neither embodied nor disembodied," writes Woolf, because Strachey inclined himself too much to invention, lacking the rich documentation of

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every aspect of Elizabeth's life that had made his *Queen Victoria* (1921) a triumph (Woolf 1942, 192).[1]

Still, Woolf saw a bright future for the kind of biography that Strachey had pioneered, and she proposes in her essay that "the biographer must go ahead of the rest of us, like the miner's canary, testing the atmosphere, detecting falsity, unreality, and the presence of obsolete conventions." The biographer's "sense of truth must be alive and on tiptoe," "hanging up looking glasses at odd corners" and enlarging the focus beyond the lives of great men to "the failures as well as the successes, the humble as well as the illustrious" (Woolf 1942, 195).

It is notable that Woolf wanted biography to portray the lives not only of emperors and generals of the past and present, but of less heroic individuals than the larger-than-life figures immortalized in Victorian literature. She was keen on the kinds of insights achieved in pioneering work of eighteenth-century English biography such as James Boswell's 1791 *Life of Samuel Johnson*, a biography which was original for its candid presentation of the personality of its subject and for its empirical foundation in documentation that included letters, private papers, conversations, and personal observations (Possing 2012, 3). Separated by the Victorian century, Boswell and Strachey each had an approach to biography that asserted equality between biographer and subject, rather than adherence to canons of hero worship, hagiography, or ethical instruction (Marcus 2002, 196; Possing 2004, 2–3).[2] Woolf liked this kind of biography, and it would be based in fact, not fiction.

19.2 Biography and History

Woolf was correct in thinking that biography would have great appeal in the future. A 1994 poll on reading habits in Great Britain found biography to be the most popular category of non-fiction book and a genre of literature considerably ahead of contemporary fiction by 19 % to 14 % of readers (Shortland and Yeo 1996, 1). A Harris poll in 2011 found that among Americans who read at least one book a year in print or electronically, 76 % said that they read both fiction and non-fiction, with 29 % of non-fiction reading including biography and 27 % history (Harris Poll 2011). Academic groups exist to advance the craft of biography and its theoretical foundations. Among these are the Zentrum für Biographik (ZetBi) headquartered at the Humboldt-University and the editorial boards of the periodicals *Journal of*

[1] Strachey's first great biographical success was *Eminent Victorians* (1918) with biographies of Henry Edward Manning, Florence Nightingale, Thomas Arnold, and Charles George Gordon.

[2] Birgitte Possing gives as an example for hero worship: Thomas Carlyle's *On Heroes, Hero-Worship, and the Heroic in History* (1841); for hagiography: John Foxe's *Book of Martyrs* (1563); and for ethical biography: Plutarch's second-century *Parallel Lives*.

Historical Biography, based in Canada, and *Journal: Life Writing* in Australia (*Journal of Historical Biography* 2012).

Yet as suggested by Robert Schneider, editor of the *American Historical Review* when he convened a roundtable on the subject of historians and biography, "academic historians have been somewhat ambivalent about the genre of biography" (Nasaw 2009, 573). In that 2009 roundtable, the historian David Nasaw described the state of affairs in the following way: "Biography remains the profession's unloved stepchild . . . Graduate students are warned away from writing biographies as their dissertations. Assistant professors are told to get tenure and promotion before taking on biography. College and university libraries, including my own, adhere to collection protocols that discourage the purchase of biographies" (Nasaw 2009, 573).[3]

Yet historians write biographies and they do so, Nasaw suggests, because "that is where the readers are," especially in the audience outside the academy (Nasaw 2009, 575). Nasaw reported in 2009 that five of the last eight presidents of the American Historical Association had written or edited biographical studies and that the Bancroft Prize in United States history had been awarded to a biography three times in the past 8 years (Nasaw 2009, 575). On an occasion marking the fiftieth anniversary of the Dexter and Edelstein Awards, given by the American Chemical Society for outstanding achievement in the history of chemistry from 1956 to 2006, it was noted that at least twenty of the fifty prize writers had tackled the craft of biography (Nye 2007, 21). These include volumes of short biographies, in a somewhat similar format if not the same spirit of Strachey's *Eminent Victorians*, but more often biographies focused on single individuals. Antoine Lavoisier is prominent among chemical subjects. Indeed six Dexter winners wrote one or more books about Lavoisier, with thematic variations that emphasized Lavoisier as the French originator of modern chemistry or Lavoisier as social reformer and revolutionary or Lavoisier as gifted experimentalist or Lavoisier as a consummate insider in the scientific elite (McKie 1936, 1952; Daumas 1955; Bensaude-Vincent 1993).

Historians use biography, Nasaw suggests, in order to illuminate not only the individual but also the points of intersection of the individual with the historical situation. The historian as biographer, he writes, "might well take as her credo" the statement by Karl Marx in his *Eighteenth Brumaire of Louis Bonaparte* that "'Men make their own history, but they do not make it just as they please; they do not make it under circumstances chosen by themselves, but under circumstances directly encountered, given, and transmitted from the past'" (Nasaw 2009, 574, quoting Marx 1963, 15). This point of view focuses the biography on choices that the biographical subject makes, the repercussions of those decisions, and the meaning of that individual's life in the historical circumstances of the time.

Similarly, the historian of science Mott T. Greene writes of biography as judgment of an individual "folded into a narrative stronger than itself"

[3] Nasaw is the Arthur M. Schlesinger, Jr. Professor of American History at the Graduate Center of the City University of New York. He is an author of biographies.

(Greene 2007, 728). In Greene's view, the aim of the biographer's craft is the building of individual character within a narrative. Certain rules must be followed, the first of which is the rule of veracity. A second rule is one of sequential order. A third rule is that of inclusion of all "important" acts and events in entirety. The fourth and final rule—reminding us of Woolf—is the rule of verifiability. While strictly keeping to these rules, the biographer is free to choose the plot (Greene 2007, 729–732).

A good plot is a good story, and a typically good story follows the scheme of *Bildungsroman* found in the novel of self-development. Greene convincingly gives us the characteristics of the story: an element of psychological and intellectual consistency in the subject's life, often first adumbrated in childhood; the autonomy achieved by the individual as "author of his own life;" and, for the artist, intellectual or scientist, the discovery or invention of something important and an account of a turning point or creative act (Greene 2007, 732–734). Other tropes consistent with *Bildungsroman* are the measurement of the biographical subject against an ideal—a Weberian ideal type—who could be imagined behaving perfectly; and the telling of the story in the folk-tale vein of the hero's quest, beset by struggles and aided by grace or magic before victory and reward are recognized in front of the assembled representatives of the realm (Greene 2007, 736–745).

Where a scientist is the biographical subject, the biographer as historian has thematic choices that are determined by the historian's own stake and interest in the matter. For example, the biography may be the **life of a scientist** (just as we might write the life of a statesman or sculptor) whose actions and values seem to the biographer to exemplify the historical period or to have affected the events of that period in a meaningful way. Or, the biography of a scientist may be **a scientific life** in which the observations, experiments or theories of the individual are keys to the understanding or the development of science of the past and the present. Lastly, the biography may be a **life of scientific collaboration** in which individuals in a community play interlocking roles that the biographer sees as key to understanding both individual lives and the organization and processes of a scientific enterprise. As we will see, these three categories are neither exhaustive nor exclusive in their boundaries, but they provide a useful framework for thinking about biography and the history of science.

19.3 The Life of the Scientist

In what I call the life of the scientist, the biography is a study of the central protagonist in a broad sweep of historical events beyond the scientist subject's expertise in a scientific discipline. Among scientists, J. Robert Oppenheimer is one of the best examples of the scientist as subject whose role in the development of scientific theory—in Oppenheimer's case, theoretical physics—is a crucial element in the story of his life, but whose narrative and dramatic interest for most biographers lies not in the technical science, but in a broader history. For many of

Oppenheimer's biographers, this is the history of twentieth-century America and Oppenheimer's rise to leadership and fall from power in the political framework of the Second World War and early Cold War. In the Preface to his book *Oppenheimer: The Tragic Intellect* (2006), Charles Thorpe contrasts some recent biographers' approaches to Oppenheimer:

> For Bird and Sherwin, Oppenheimer was an authentic voice of American scientific, intellectual, and political liberalism. For McMillan, he was a defeated moderating voice in American foreign policy . . . Schweber suggests that Oppenheimer was 'too fractured an individual' to handle the ethical and political dilemmas presented by Hiroshima and the Cold War, and he instead presents physicist Hans Bethe as the more consistent embodiment of an ethic of responsibility.

Thorpe further characterizes David Cassidy's life of Oppenheimer as a demonstration of the ways in which a new alliance of science, industry, and military power undermined the independent cultural authority of science. Echoing almost perfectly Greene's description of the Weberian ideal type for plotting biography, Thorpe writes that his own biography of Oppenheimer is a sociological biography that reflects Max Weber's idealist themes of "vocation, responsibility, cultivation and expertise, charisma, bureaucracy, instrumental reason, fact and value, means and ends" (Thorpe 2006, xiv–xvi; Bird and Sherwin 2005; McMillan 2005; Schweber 2000, 2012; Cassidy 2005). Schweber, too, explicitly invokes Weberian ideals in his contrast of Oppenheimer and Bethe (Schweber 2000, 14, 15, 93).

Many lives of scientists narrate the protagonists' scientific struggles and achievements as part of a life lived daily in a larger public culture. Biographies of Max Planck come to mind (Heilbron 1986; Hoffmann 2008). Einstein biographies are a primary example, too, and there are so many of them that the Einstein scholar Don Howard called for a temporary moratorium in his review of Walter Isaacson's 2007 book *Einstein: His Life and Universe*. On the whole, Howard liked Isaacson's biography, but Howard judged that Isaacson's treatment of Einstein's physics was insufficiently central to the book and lacked technical proficiency. "Move the chronology and the broader context into the foreground, as does Isaacson," wrote Howard, "and one risks that the science will seem incidental to the rest of the subject's life." Yet, "Present relativity as a single package" thematically in the biography" and "one loses both the narrative thread and a vivid sense of the way Einstein's scientific work was situated in a personal, professional, and political context" (Howard 2008, 126).

Some biographies of scientists living in the greater historical world better meet Howard's demands. He mentions Ruth Sime's book *Lise Meitner: A Life in Physics* (1996), which, like David Cassidy's *Uncertainty: The Life and Science of Werner Heisenberg* (1991) acquired a sales audience of over ten thousand readers despite the detail in which the scientist's physics is described (Howard 2008, 125; Sime 1996; Cassidy 1991).[4] Both biographies narrate and interrogate the responsibilities

[4] I am grateful to Ruth Sime and David Cassidy for answering my question about sales.

and choices of their subjects in the political and moral culture of early twentieth-century Germany, showing the strengths and weaknesses of unfolding character over time.

In her 1998 biography of Fritz Haber, Margit Szöllösi-Janze explicitly lays out her problem as biographer in constructing a biography that captures the complexities and meanings of Haber's life, including the science. There was the good Haber, and there was the evil (bösen) Haber. One was the genial scientist and Nobel Prize winner, the benefactor of agriculture through his synthesis of ammonia, and an intimate friend of Einstein and Planck. There also was the bad Haber, the nationalist and militarist, the war criminal responsible for gas warfare, and the coldhearted tyrant who drove his sensitive wife to kill herself. Haber's biographers have to choose what to capture of the many aspects of that life, including the scientific culture of Germany, the organization of the war economy, and financial hyperinflation after the Great War (Szöllösi-Janze 1998, 9, 15). Szöllösi-Janze succeeds admirably in unfolding Haber's life in a chronological sequence of events that are given structure by the themes of Haber's daily life and by nuances of moral judgment. The book is a prime example of the life of a scientist and of biography as history.

19.4 The Scientific Life

The appellation "scientific biography" applies to different formats for biography, but it applies most precisely to the biography in which the principal interest is the science of the scientist and the contribution of the biographical subject to scientific knowledge.

The pitfalls of scientific biography are highlighted in a review of a recent 600-page biography of the French physicist and mathematician Henri Poincaré: "Of its twelve chapters only the second, entitled 'Poincaré's Career,' tells the fascinating story of Poincaré's life in plain English" (Von Bayer 2013, 362). The scientist's life as his scientific experiments and ideas often has been preferred by scientists, as reflected in the comment by biologist and sex researcher Alfred C. Kinsey that it is nonsense to write a scientist's biography because "The progress of science depends upon knowledge. It has nothing to do with personality" (Capshew et al. 2003, 465, quoting Pomeroy 1972, 431–432).

First and foremost in writing a biography of the scientific life, the biographer wants the reader to understand the subject's scientific achievement. The biographer wants to explain how the scientist came to choose a problem, how results were obtained, and how the scientist's contributions were judged both at the time and later in history. The biographer Richard Holmes suggests the need for a full sense of this scientific life. "We want to read about scientific work as part of a life story—to know what makes a scientist tick, and what set them ticking" (R. Holmes 2012, 498). For Holmes, biographies should reveal the crucial shaping power of childhood and youth, the nature of the creative process, the inner and emotional life of

the scientist, and the ways in which error and uncertainty are central to discovery in ways that are lost in the official scientific literature (R. Holmes 2012, 499).

Holmes further describes science itself, not just biography, as a story—a detective story, a mystery story, a love story (R. Holmes 2012, 499). As analyzed by Greene, the story has the elements of the hero's quest with adumbrations in childhood, the search for the holy grail, the struggles and moments of magic and insight, wrong turns, and triumphant recognition of the hero. The biography of a scientific life may delve deeply or superficially into the daily peregrinations of the hero while following the protagonist's mathematical calculations, research notebooks, diaries, published papers, and networks of citations and collaborations in the scientific life. Much depends on documentation, interviews, and insights available to the biographer, as well as the biographer's particular interests.

Different approaches can be chosen, as in two biographies of Paul Dirac. Helge Kragh's study is titled straightforwardly *Dirac: A Scientific Biography* (1990). Most of the book's chapters treat Dirac's different interests and achievements in theoretical physics in their historical context, with some chapters devoted to Dirac's personal life, travels, and philosophical thoughts. "Because Dirac was a private person, who identified himself very much with his physics, it is natural to place emphasis on his scientific work, which, after all, has secured his name's immortality," writes Kragh (1990, ix). In contrast to Kragh, however, the biographer Graham Farmelo gauged that Dirac's private life held the key to understanding the scientific work, and Farmelo titled his 2009 biography *The Strangest Man: The Hidden Life of Paul Dirac, Mystic of the Atom*.

Making extensive use of private papers held in the Dirac family and engaging in detailed conversations with members of the family, Farmelo describes Dirac's extraordinary investigations and achievements in quantum mechanics, relativity, and electrodynamics, but he also analyzes the "hidden life" behind Dirac's eccentric peculiarities and extreme shyness in order to try to account for Dirac's reputation as a man second only to Einstein in originality and brilliance. The biography is organized into 31 chapters, the first titled "Until August 1914" and the last two titled "On Dirac's Brain and Persona" and "Legacy." The 28 intervening chapters have titles such as "September 26–January 1927" and "January 1927–Spring 1927." The result is a seamless chronology and a personal biography that has been praised by reviewers as diverse as the physicist Peter Higgs of the Higgs boson and the playwright Tom Stoppard (Farmelo 2009, book jacket).

Another biography of a scientific life that has received acclaim is Kostas Gavroglu's 1995 book *Fritz London: A Scientific Biography*, which focuses on the life and work of a physicist who played a major role in the development of theories in quantum chemistry and low temperature physics. The biography is organized chronologically for the most part, with London's work in the application of quantum mechanics to chemistry, the theory of superconductivity, and the theory of superfluidity organized roughly by the chronology of London's years in Berlin, then in Oxford and Paris, sandwiched between the early years in Germany and the last years at Duke University in North Carolina. London was a major player in theoretical physics, but he was not a superstar like Einstein or Dirac, nor was he an

institutional leader or a member of editorial boards or a writer of popular articles. In short, London's life was his scientific work, his family, and a small circle of friends.

In depicting this scientific life, Gavroglu outlines his aim as two-fold: the biographical purpose of explaining why one path rather than another was followed by London and the historiographical purpose of placing London into the perspective of what Thomas S. Kuhn called the working of normal science (Gavroglu 1995, xv). Many of the tropes of the *Bildungsroman* and the hero story are followed in the biography, although verifiable documentation does not allow Gavroglu to speculate, he writes, on the possible effects of London's early years on his later life. There are available, however, London's early philosophical essays and doctoral thesis, before he turned to physics, and these provide a "coherence in the narrative" that reveals London consistently fighting against reductionism and advocating phenomenological theories that account for behavior at the macroscopic rather than the microscopic level. "I argue," Gavroglu writes, "that there is a continuity from his thesis in philosophy to his work in superfluidity" (Gavroglu 1995, xiv–xv, 13, 118, 127, xviii).

There are struggles as well as triumphs in London's scientific life, among them his disputes over matters of interpretation and priority in quantum chemistry with Linus Pauling, John Slater and Robert Mulliken; in superconductivity with Max von Laue; and in superfluidity with Lev Landau and Laszlo Tisza. There is a magical eureka moment in 1927, which occurs in solving the problem of hydrogen bonding, although the story is recounted by London's co-author Walter Heitler rather than by London. They had begun working together in Zürich on the problem of homo-polar bonding from the perspective of Van der Waals forces, although they were aware of Heisenberg's recent paper on quantum mechanical resonance in which Heisenberg defined the exchange integral for two electrons. Talking with John Heilbron in 1963, Heitler recalled (Gavroglu 1995, 45):

> Then one day was a very disagreeable day in Zürich; [there was the] Fohn. It's a very hot south wind, and it takes people different ways . . . I had slept till very late in the morning, found I couldn't do any work at all . . . went to sleep again in the afternoon. When I woke up at five o'clock I had clearly—I still remember it as if it were yesterday—the picture before me of the two wave functions of two hydrogen molecules joined together with a plus and minus and with the exchange in it. So I was very excited, and I got up and thought it out. As soon as I was clear that the exchange did play a role, I called London up; and he came as quickly as possible.

This creative moment plays the dramatic role of an epiphany experience similar to August Kekulé's dream of a snake holding its tail (the benzene ring) or Isaac Newton's falling apple (gravitation theory) or Heisenberg himself suddenly seeing his way to a quantum mechanics without electron orbits while he was recovering from an asthma attack on the barren island of Helgoland. These stories become the myths that establish the special gift to the hero.

Gavroglu shows, too, the everyday activities of the painstaking work that constitutes normal science for scientists as they seek to solve problems both big and small. London's wife Edith told Gavroglu that kind of story. In the summer of 1934 Fritz London's brother Heinz was staying with Fritz and Edith in Oxford,

where the brothers were working with the low-temperature physics group at Clarendon Laboratory. Fritz and Heinz were in the habit of working together for hours, usually during the daytime after Heinz had been in the laboratory until late at night. At the end of August they were also having long conversations at night. Edith recalled, "I was in the kitchen cooking and suddenly the upstairs door was opened by Fritz. 'Edith, Edith come, we have it. Come up, we have it' . . . Fritz said 'The equations are established. We have the solution. We can explain it'" (Gavroglu 1995, 118).

Narrating the processes of scientific creativity and the confirmations and disconfirmations of experimental or theoretical results is one of the major preoccupations of biography as the scientific life, as exemplified in Gavroglu's *London*. Among the masters of this technique was Frederic Lawrence Holmes. His 1985 study of *Lavoisier and the Chemistry of Life*, like his two-volume study of Hans Krebs (1991, 1993) and his first book of 1974 on Claude Bernard, aimed to use records of the scientist's life in order to chart the torturous, interlocking, and unpredictable avenues by which scientific experimentation and reasoning work. Holmes's scientific lives were dense and technically detailed narratives of scientists' laboratory work and of what he called their "investigative pathways." Laboratory notebooks were the essence of the story, with little mention of political, administrative, philosophical, or family preoccupations of the biographical subject (F. Holmes 1974, 1985, 1991, 1993, 2004). Holmes's aim, like many authors of scientific biography, was to show the excitement of science, the passion for science, and the very hard work and struggles typical of science—both the Eureka moments and the Sisyphean moments of scientific life.

Michael Polanyi, who was a colleague and collaborator with London in Berlin, caught the dichotomy between epiphany and the kind of struggle that he called the "slough of despond" (Polanyi 1949), as well as the distinction between revolutionary and ordinary scientific work, in his (modestly worded) statement that (Polanyi 1969, 97):

> the example of great scientists [like Einstein] is the light which guides all workers in science, . . . we must guard against being blinded by it. There has been too much talk about the flash of discovery and this had tended to obscure the fact that discoveries, however great, can only give effect to some intrinsic potentiality of the intellectual situation in which scientists find themselves. It is easier to see this for the kind of work that I have done than it is for major discoveries.

19.5 The Life of Scientific Collaboration

Like Thomas Kuhn, Polanyi reached a point in his career when his interests turned from doing science to thinking about the philosophy of science. In Kuhn's case, the turn came at about the time that he was completing his doctorate in solid-state physics. For Polanyi, it came after a successful career of more than 25 years in physical chemistry that included laboratory directorships in Berlin and Manchester. Both former scientists insisted that more attention should be paid by historians of

science and philosophers of science to the structure and behavior of the scientific community in order to understand how scientific knowledge is achieved. A focus on scientific collaboration as biography in science is such an approach. How was a particular scientific collaboration constituted, who were its members, what were their aims, how did they go about working together, and what did they achieve? The goal is biographical, observing tropes and rules of biography, but the purpose is also more broadly to write the history of science.

For purposes of biography, scientific collaboration may be defined by a membership of two or three or of dozens or more. In *QED and the Men Who Made It*, S. S. Schweber portrays a large community in quantum mechanics, with a particular focus on the four physicists Freeman Dyson, Richard Feynman, Julian Schwinger and Sin-Itiro Tomonaga (Schweber 1994). Schweber's study of Oppenheimer and Bethe perhaps fits into the category, too, of collaborative biography since Schweber here deals with interlocking lives more than with parallel lives. Istvan Hargittai has used this format in the way that he plots his study of five Hungarian physical scientists in the book *Martians of Science*, while Lois Banner is explicit about entanglement in her book *Intertwined Lives* on Margaret Mead and Ruth Benedict (Hargittai 2008; Banner 2004).[5]

Some of the most compelling collaborations for biography are biological families in science, such as the Cassinis, the Bernoullis, the Becquerels, the Curies, the Darwins, and the Huxleys, linked together by successive generations or by sibling ties or as husband and wife (Abir-Am and Outram 1987; Pycior et al. 1996). Lauren Redniss's *Radioactive: Marie and Pierre Curie. A Tale of Love and Fallout* (2011) is an unorthodox biography of a scientific husband and wife, lavishly illustrated with the author's own artwork and interspersed with vignettes on the uses and perils of radioactive elements, but thoroughly well documented in traditional historical sources. In writing the book, Redniss says that she self-consciously ignored the advice of the Curies' granddaughter Hélène Langevin-Joliot to avoid telling the Curies' lives as a fairy tale (Redniss 2011, 187, n. 30).

John Jenkin's 2008 study of the physicist father and son William and Lawrence Bragg is an example of a more orthodox recent biography of a scientific family, as are Michael Hoskin's 2007 volume on the astronomical Herschels of Hanover (the overlapping lives of three brothers and a sister) and Deborah R. Coen's *Vienna in the Age of Uncertainty*. Coen's title does not immediately tip the reader to her richly detailed biographical study of three generations of family life and collaborative work in physics, physiology, meteorology, and animal behavior in the Viennese Exner family's scientific dynasty from the 1840s to the 1920s (Jenkin 2008; Hoskin 2007; Coen 2007). Coen's approach is considerably more rich and complex than

[5] Hargittai's five Martians are Theodore von Kármán, Leo Szilard, Eugene Wigner, John von Neumann, and Edward Teller.

simple portraits of individuals. She demonstrates the influences of early experiences, but she also shows the insufficiency of family biology or essentialism to explain the choices, values, and destinies of her major protagonists.

Another kind of collaborative biography is what Laura Otis in her 2007 book *Müller's Lab* christens "labography" (Otis 2007; Nye 2009). The labography is biography on a different scale than the prosopographical approach advocated by Steven Shapin, Arnold Thackray and Lewis Pyenson in the mid-1970s, and it is more psychological and personal than most studies of research schools (Shapin and Thackray 1974; Pyenson 1977). Otis examines the relationships between the distinguished nineteenth-century physiologist Johannes Müller, who taught in Bonn and Berlin, and seven of his students and protégés, who included Emile du Bois-Reymond, Hermann von Helmholtz, and Ernst Häckel. The labography offers detailed descriptions of daily routines of lecture halls, rooming houses, museums and hospitals, as Otis describes experiments conducted in personal apartments and public institutions. Competition between students, desire for their mentor's praise, and individual struggles to win independence from the master all fit into classical tropes of *Bildungsroman* even while the labography traces the sociology and psychology of private and professional scientific life in mid-nineteenth century Germany. Like Richard Holmes, Otis insists upon the passion of intellectual work, using metaphors of infatuation and seduction, while she also reveals the power of social bonds and personal rivalries (Otis 2007, 233–235).

A worry about biographies is that the typical traditional biography too often has concentrated on stories that are easy to tell, or, as suggested by Greene, on scientists whose lives are most easily structured as the hero's successful and victorious quest. Thus biographies of Darwin abound, while fewer biographers have tackled Mendel's life (Greene 2007, 746–750). In somewhat the same vein as Polanyi, Greene suggests that biography creates a distortion in the representation of science, because traditional biography "is not meant to construct or represent normal or average performance. . .. creative workers whose lives do not fit the template of the hero's quest are denied biographical treatment" (Greene 2007, 751).

What I am calling the biography of scientific collaboration is an approach to scientific life that does not distort the processes of science by overly emphasizing the role of the individual, although inevitably focusing on individuals. The biographical studies by Jenkin, Hoskin, Coen, and Otis all point to this aspect of science that often is downplayed by concentration on the single life. That aspect is made explicit in Jenkin's title for his biography of the Braggs: "the most extraordinary collaboration in science." Gavroglu does not make the claim of extra-ordinary for the collaboration of Fritz London with Walter Heitler or with Fritz's brother Heinz, but Francis Everitt gets at the importance of the fact of collaboration in his review of Gavroglu's book (Everitt 1996, 1273).

> All his life, Gavroglu notes in this biography, London had a habit of retreating into himself and 'writing a long piece to clarify the conceptual issues of a particular problem.' That being so, it is biographically fundamental that his two determinative scientific papers were collaborations, the first (1927) on quantum chemistry with Walther [sic] Heitler, the second (1935) on superconductivity with his younger brother Heinz. This introverted man needed

> other people. Even his third masterwork, the Bose-Einstein theory of superfluidity (1938), grew out of intense discussions with Laslo [sic] Tisza at one of the very few scientific conferences London attended.

Gavroglu's bibliography for London's published writings lists 67 papers and three books, one of the books co-authored with the French physicist Edmond Bauer. Among the papers, 13 were co-authored, including Fritz London's first scientific paper on the intensity of band spectra written with Helmut Hönl. While in Berlin, Fritz co-authored five papers bearing on chemistry, three of them with Harmut Kallmann, one with Robert Karl Eisenschitz, and one with Polanyi. Berlin provided a professional and social environment of weekly colloquia and research laboratories in which collaboration was especially easy or desirable, and chemistry was a discipline in which collaboration was more common than in theoretical physics. Polanyi, for example, headed research laboratories at the Kaiser Wilhelm Gesellschaft in Berlin and at Manchester University. He authored 218 scientific publications from 1910 to 1949, including one book. Of his papers, 132 were co-authored with 76 different co-authors (Wigner and Hodgkin 1977, 437–445). The study of Polanyi's or other scientists' most frequent co-authors, like research into patterns and styles of collaboration, not only can provide important insights into the intersections between the scientist's social and scientific lives but into the normal processes of science at the time (F. Holmes 2001).

Another of Greene's worries about biography lies in this very area of collaboration. As studies of the history of science push into the sciences of the twenty-first century, biographers will find that much of scientific production no longer appears as single-authored papers or jointly authored papers by just two or three authors with clearly delineated responsibilities. This situation is already true in many areas of the physical and biological sciences. "In such an environment, where a lifetime of publications by a given scientist may include only a few book reviews, review articles, and think pieces as single-author efforts, it becomes quite difficult to see how biography will find the materials to get its job done" (Greene 2007, 753–754).

The case for biography of recent scientists likely is not so bleak. Historians already are systematically working with individual scientists and with archivists and museum curators in order to supplement written records with oral histories and with the means to preserve electronic records that currently exist only in digital clouds. Projects at the American Institute of Physics, the Chemical Heritage Foundation, and the Max-Planck-Institut für Wissenschaftsgeschichte are among examples of this kind of effort, as is the Royal Society's October 2012 launch of a public and popular project for writing women into the history of science (Royal Society of London 2012). Scientists write lively and informative accounts of themselves and their work in their autobiographies, and some scientists, as Thomas Söderqvist puts it, lead a "biographical life" by saving absolutely everything (Söderqvist 2003, xviii). Biographers have always depended on scientists themselves for evaluations of what matters in science, just as biographers respond to the judgments of artists or novelists or politicians or economists about the state of things and who did what. Biographers then bring their historical tools, critical perspectives, and literary tropes to the final biographical project.

19.6 Concluding Reflections

My examples have been drawn mainly from the history of twentieth-century physical sciences and from biographies published as books. As a historian, I have written three books that qualify as biography. My books on Patrick Blackett and on Michael Polanyi fit best into the category of biographies of scientists in which the protagonist's scientific work is crucial to the life, but in which the science often takes a temporary or permanent back seat to the scientist's preoccupations and responsibilities as statesman, administrator, government advisor, military officer, political activist, economic writer, or philosopher in a wider arena outside the laboratory. In contrast to the Blackett and Polanyi books, my earlier biographical study of Jean Perrin, despite his huge and influential role in French politics, education, and scientific institutions, focused almost entirely on Perrin's scientific work in his most creative years from the mid-1890s to the outbreak of the First World War (Nye 2004, 2011, 1972). My approach to Perrin's quest for experimental proofs of what he called "molecular reality" is very much in the folk-tale vein of the heroic venture, its struggles, and triumphs, unlike a later biography by Micheline Charpentier-Morize (Charpentier-Morize 1997). In contrast, while they are in no way life biographies on the scale of Sime's *Meitner* or Cassidy's *Oppenheimer* or Isaacson's *Einstein*, my biographies of Blackett and Polanyi fit the model of *Bildungsroman* and Weberian interrogation.

The fact, as we have seen, that there are multiple biographies of a single biographical subject reminds us that Virginia Woolf had to be at least partly wrong in writing that biography is a craft and not an art. There is no truth to be discovered about the man or the woman or the collaborative group at the heart of the biographer's story, and there are as many different stories as there are different times and places and sensibilities in biographers' own lives. A recent biography that explicitly makes this point is Nicolaas Rupke's *Alexander von Humbolt: A Metabiography*, a study of how Humboldt's life was configured and reconfigured during the course of the nineteenth and twentieth centuries by his biographers (Rupke 2005). As Steven Shapin writes in his review of Rupke's book, "shifting biographical traditions make one person have many lives" (Shapin 2006).

I have concentrated on the topic of biography and history—specifically the history of science—rather than on the theme of biography and literature. In his quest to highlight what he calls the "poetics" of scientific biography, Thomas Söderqvist has written that more needs to be written by way of literary criticism of biographies of scientists, and that this would be a good thing (Söderqvist 2007, 6). Graham Farmelo's portrayal of Dirac's "hidden life" is deeply poetic and literary in tone and effect, as is Söderqvist's own approach of existentialist biography in his life of the immunologist Niels Jerne. Writes Södervist, "this is a biography of Niels Jerne, not a contribution to the history of immunology disguised as biography"

(Söderqvist 2003, xxiii). In a similar vein, Ray Monk writes of his biography of Oppenheimer: "what *most* interests me is Oppenheimer *himself*" (Monk 2013, xiv).

Biographers have many different aims and methods, and biographers of scientists often confront the problem of the highly technical aspects of their subjects' life work in scientific research. Again, Monk writes that if he is to understand Oppenheimer *himself*, Monk as Oppenheimer's biographer must "attempt to understand his contributions to science" (Monk 2013, xiv). Whether written as a life of a scientist or a scientific life or a collaborative life or something else, biography is a difficult and challenging genre, and especially so, for the historian of science with a literary sensibility.

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