The prodigious life and untimely death of "Harry" Moseley

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"My Harry was killed in the Dardanelles" is the entry from 10 August 1915 in the diary of the mother of Henry ("Harry") Gwin Jeffreys Moseley. He was shot on that day in the head during the failed Anglo-French invasion of the Ottoman Empire from the sea. The previous year, when he volunteered to join Lord Kitchener's New Army, he was nominated for two Nobel Prizes, one for chemistry and one for physics, for his work on X-ray spectroscopy and atomic structure. Moseley's tragic death at age 27 was widely reported not just in the Allied countries, but also in Germany. Its futility fired up Ernest Rutherford, Moseley's mentor, to write an indignant letter to *Nature*: "It is a national tragedy that our military organization at the start of the war was so inelastic as to be unable, with a few exceptions, to utilise the scientific services of our men, except as combatants in the firing line. Our regret for the untimely death of Moseley is all the more poignant."

Three years before, as Rutherford's affiliate at the University of Manchester, Moseley recognized that "a platinum target [upon electron impact] gives out a sharp line [X-ray] spectrum … which [a] crystal separates out [into monochromatic lines] as if it were a diffraction grating … There is here a whole new branch of spectroscopy which is sure to tell one much about the nature of an atom." This letter of Moseley, addressed, as so many of his other letters, to his mother, marks the beginning of X-ray spectroscopy. But what do the X-ray spectra tell us about atoms? The discovery, in 1912, by Max von Laue, Walter Friedrich, and Paul Knipping of the X-ray diffraction by crystals and its analysis by William and Lawrence Bragg prepared the soil for using X rays as an incisive tool for investigating matter. However, it was Rutherford's planetary atom and its refinement within the framework of the old quantum theory by Niels Bohr, another of Rutherford's illustrious affiliates, that provided the link between X rays and atomic (electronic) structure. These were confusing times, however, with no clear understanding of the origins of radioactivity, the displacement law, and isotopy, although all these notions were in circulation already and the reality they aimed to capture loomed large as one of the main preoccupations of both chemistry and physics.

Moseley's feat, for which he teamed up with Charles Galton Darwin (the grandson of the author of "On the origin of species") and Niels Bohr, was the demonstration that the first-period transition metals conform to what would become known as "Moseley's law:" the square root of the frequency of a given X-ray series, $\nu^{1/2}$, of the elements is proportional to N-a, where N is an integer that changes by one between adjacent elements in the periodic table and a is a screening constant. The screening constant, a Bohr-model construct, is intimately connected with identifying N with the atomic number and the atomic number with the nuclear charge, Z. Moseley's work on elements with Z=20-30 was presented in Part I of his classic "The high-frequency spectra of the elements," published in December 1913. Part II, completed after Moseley's move to Oxford and published in April 1914, dealt with elements with Z=69-71 (and the search, in vain, for element 72). Moseley would not live long enough to publish Part III, on the spectra of rare earths.

From early on, Moseley's work was regarded as having resolved the baffling issue of the ordering of the elements in the periodic system – by the atomic number (nuclear charge) rather than atomic weight (and rendered, e.g., the cobalt–nickel sequence right). In 1915, Moseley was nominated for the Nobel Prize in both Physics and Chemistry. The nominator was the same in either case, namely Svante Arrhenius. Moseley's death in the summer of that year disqualified him from the competition for the award. However, that the Nobel Prizes in Physics for the years 1917 (to Charles Glover Barkla "for his discovery of the characteristic Röntgen radiation of the elements") and 1924 (to Manne Siegbahn "for his discoveries and research in the field of X-ray spectroscopy") were awarded for contributions closely related to Moseley's achievements suggests that he would have been indeed a serious contender.

All of the above and more has now been detailed in a volume entitled “For science, king, and country. The life and legacy of Henry Mosely,” edited by Roy MacLeod, Russell G. Egdell, and Elizabeth Bruton, and published by the University of Chicago Press in 2018. In Part One (Life), five chapters describe Moseley’s upper-middle class origins, upbringing, and education at Eton and Oxford, his time at Rutherford’s laboratory in Manchester, the technical aspects of Moseley’s work in X-ray spectroscopy, “the meteoric pass through the clouds of physics ” (in John Heilbron;’s words) of Antonius van den Broek, as well as Moseley’s training as a reserve officer and his deployment and death as a signals officer in the Dardanelles (Gallipoli). Part Two (Legacy) discusses the politics of Nobel prizes and their correlation with the Matteucci medal, X-ray spectroscopy and the discovery of new elements, and the state of the art in X-ray spectroscopy. The last chapter reports about an exhibition at the Museum of the History of Science of the University of Oxford that marked the centenary of Moseley’s death. Entitled “Dear Harry,” the exhibition was divided into three sections, on Moseley the son, the scientist, and the soldier, with many artefacts on display (and reproduced in the volume) illustrating these three aspects of Moseley’s life.

My personal favorite is the chapter “Accounts of Moseley and versions of his laws” by John Heilbron. The chapter is a booming echo of Heilbron’s masterful 1974 biography “HG.J. Moseley. The life and letters of an English physicist, 1887-1915” (University of California Press, Berkeley), which remains the authoritative source on Moseley. On just a few pages, Heilbron traces the genesis of “Moseley’s law” as an expansion of the experimental basis of the old quantum theory as well as emphasizes the key influence that Niels Bohr, one of the theory’s principal proponents, exercised over both Moseley and Rutherford. After all, Rutherford’s 1911 planetary (or nuclear) atom got traction only after Bohr co-opted it two years later into his quantum atom. Heilbron also identifies Richard Widdington’s 1911 observation about the threshold electron energy needed to excite a given X ray as the key empirical insight that guided Bohr to adopt nuclear charge as defining an atom’s identity.

On the human side, Heilbron doesn't shy away from debunking the romantic myth according to which Moseley's death made the prodigious young man "even more immortal" and reminds us that "during the war Moseley's death was taken as a symbol of the wastefulness of combat and the stupidity of generals." Heilbron concludes with a counter-factual speculation about where Moseley's research would have led him had he not been killed in the Dardanelles: nuclear fission.

The Appendices of "For science, king, and country" provide a guide to the rather arcane labeling of X-ray spectra, reprint primary accounts of Moseley's death, and list memorials to Moseley and online lectures and films about him. The Bibliography lists all 10 papers written by Moseley as well as 31 biographical articles and books about him.

All in all, the volume covers not only Mosley's life and work, but also transcends it in many ways. It is a pasture for the curious mind and I highly recommend it to scientists, historians, historians of science, and lay readers alike.

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