

**Jacqueline Mitton and Simon Mitton, *Vera Rubin: A Life*
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The astronomer Vera Rubin (1928–2016) can be regarded as the American counterpart of Dorothy Hodgkin. Both high-achieving female scientists with four children, they deserve to be far better known, but – unlike Rosalind Franklin or Marie Skłodowska Curie – lack the promotional value of either victimhood or martyrdom. This lively and comprehensive biography should do much to enhance Rubin's reputation at a time of growing public interest in retrieving neglected women.

Vera Rubin: A Life is unusual in being initiated by the publisher rather than by its authors. Themselves both astronomers and experienced writers, the married couple Jacqueline and Simon Mitton responded to an appeal put out by Harvard University Press shortly after Rubin's death; excellently qualified for the task, they were enticed by the prospect of becoming her first biographers. The dust jacket reveals that, like their subject, they had been honoured by having an asteroid named after them, while Simon Mitton was the editor who informed Stephen Hawking that every equation in *A Brief History of Time* would halve the number of sales.

Meticulous researchers, the Mittons have accumulated an impressive array of information about every stage and facet of Rubin's life. Although a more popular account by the science journalist Ashley Jean Jaegar appeared only a few months later, *Vera Rubin: A Life* currently provides the fullest discussion of Rubin's personal experiences as well as her scientific achievements. Yet in an interview for the American Institute of Physics, Jacqueline Mitton apparently had no qualms in explaining how the couple divided up the work for their project: following what might seem traditionally gendered lines, she wrote the bulk of the book and carried out all the time-consuming tasks such as indexing, gaining picture permissions and collating revisions, while her husband acted as overall consultant and contributed the three scientific chapters.

Conventionally structured as a chronological womb-to-tomb narrative, *Vera Rubin: A Life* opens with her father's origins in Lithuania and his family's bid to evade Jewish persecution by emigrating to the United States. Born twenty-five years later, Rubin herself is introduced as a child prodigy inspired by an early Eureka moment of spotting meteors from her bedroom window; as the Second World War raged in Europe, she became so fascinated by the stars that she built her own telescope in the back garden. After this introductory material, the authors embark on a double mission: to give a detailed account of Rubin's subsequent rise to international fame; and to explore her personal life and the implications of what was then the very unusual decision to combine motherhood with a scientific career. They remain judiciously neutral on the vexed question whether she should have won a Nobel Prize.

Although Rubin is regularly celebrated as the discoverer of dark matter, the Mittons are careful to explain that her reputation rests on a rather different feat – her long-term accumulation of observational evidence supporting the existence of dark matter, a hypothesis first put forward by Fritz Zwicky in 1933. From the mid-1960s onwards, Rubin and her colleague Kent Ford investigated how stars and gas clouds revolve in the

outer reaches of spiral galaxies, confirming in experiment after experiment that at great distances from a galactic centre, stellar objects contravene standard mathematical predictions, instead behaving as if some invisible substance were influencing their motion. According to modern estimates, 85 per cent of the universe consists of undetectable dark matter and energy. The Mittons do not mention the alternative explanation currently being proposed by some astrophysicists that the laws of gravity need to be modified. This is an appealing suggestion for historians who reflect that relativity theory was itself introduced to obviate the need for assuming an all-pervasive aether.

Taught by her mother that 'Actions speak louder than words' (p. 3), Rubin fought against gender prejudice throughout her career. She first encountered discrimination at school, when, after she won a scholarship to women-only Vassar College, her male physics teacher warned her to stay away from science. This was an early example of the cruel or simply thoughtless put-downs that she repeatedly confronted as a female scientist. Initially, Rubin tackled problems as they arose: on discovering that the Palomar Observatory had only one lavatory, she boldly stuck a cut-out paper figure in a skirt on the door and marched through it. But, during the 1970s, inspired by her colleague Margaret Burbidge's refusal to accept an astronomical award reserved for women, Rubin began campaigning systematically and was extremely influential.

But as the Mittons insist, Rubin also paid particular attention to language, adopting the motto 'we are what we say' (p. 220), a declaration that sits uneasily with their own habit of mostly (although not consistently) referring to men by their surnames and women by their first names. Jocelyn Bell Burnell, famous for her work on pulsars, once remarked that survival as a female physicist entails being a superwoman. In her brief foreword to this biography, she praises Rubin as a feminist trailblazer endowed with great 'tenacity' (p. ix). The Mittons's account is unremittingly laudatory, yet it is laced with similarly double-edged terms such as 'determined' or 'had strong and considered opinions' (p. 213). Reading between the lines, Vera Rubin succeeded by adopting tactics traditionally labelled masculine.

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