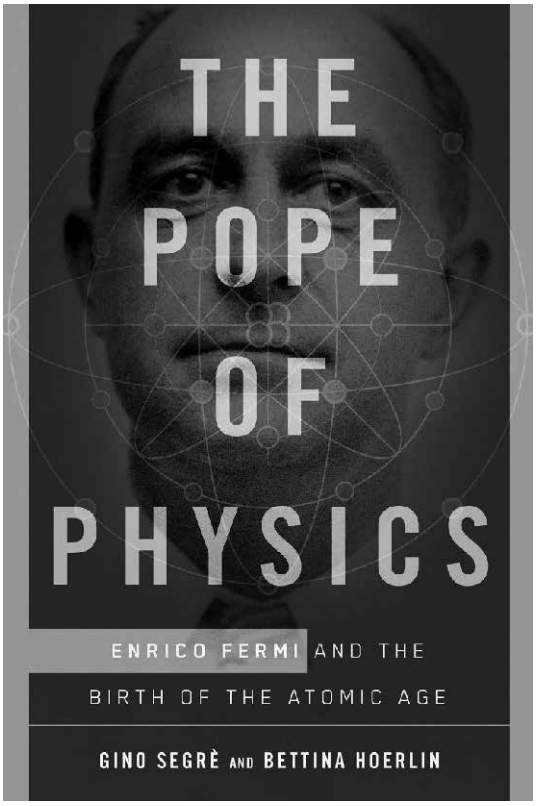
Book review

Gino Segrè and Bettina Hoerlin

The Pope of Physics

Reviewed by Philip Yock*



Enrico Fermi was one of the towering figures of twentieth century physics and often considered the last person to have known all of physics. Not for him the title 'theoretical physicist', or 'experimentalist' – his realm was physics wherever that might take him. He made seminal contributions to quantum field theory, beta-type radioactivity, nuclear interactions induced by neutrons, nuclear fission and the origin of cosmic rays. He earned the title 'Pope of Physics' in his home country of Italy because his judgements on physics turned out to be, with one possible exception, unfailingly correct. He is remembered as Italy's most famous scientist since Galileo.

This book by the husband and wife team of Gino Segrè and Bettina Hoerlin provides an engagingly written biography of Fermi's life and achievements. It provides an excellent companion volume to the biography *Atoms in the Family* written by Fermi's wife in 1954, which, as might be expected, provides more personal insight into Fermi's character, and also excellent descriptions of the experiments conducted by Fermi in terms a non-scientist can readily appreciate. The present book does not provide full details of the experiments conducted by Fermi, nor the theories he propounded, but it is clear this was not the intention of the authors.

The book opens with brief remarks on Fermi's boyhood, in which he carried out experiments on electric motors and gravity's acceleration, and read lengthy treatises on mathematics in Latin and on physics in French. He eventually attended the Scuola Normale Superiore at Pisa and received a doctorate magna cum laude in physics. He is described as a brilliant student who was largely self-taught, perhaps as many pioneers are.

We also learn from the biography that Fermi was an inveterate scientist and teacher, who enjoyed spending time with students talking physics. He also enjoyed competitive sports such as hiking, skiing, tennis and swimming. His wife Laura studied general science at university, including physics, and she is said to have contributed to Fermi's general happiness. He admired her wit and intelligence, which are so evident in her biography *Atoms in the Family*, and he left parenthood mainly to her.

Fermi wrote pioneering papers on the quantisation of the electromagnetic field at an early age, which placed him on a par with Paul Dirac, and these were followed by his ground-breaking theory, famously rejected by *Nature*, of beta-type radioactivity, in which he correctly proposed that particles actually change their identities in the decay process.

In the early years, while Fermi was still in Rome, an accomplished group formed around him known as 'the boys'. This included Emilio Segrè, Franco Rasetti, Edoardo Amaldi, Oscar D'Agostino, and Bruno Pontecorvo. Under Femi's leadership they conducted experiments in which elements covering most of the periodic table were bombarded with neutrons. These led to the discovery of many new nuclear isotopes and comprised Fermi's Nobel Prize-winning work.

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These experiments also led to the discovery that slow neutrons were more effective in inducing nuclear interactions than fast neutrons, a discovery which reputedly used a goldfish pond at Rome University as a moderator to slow neutrons down.

But the neutron experiments included one possible blunder, viz. the apparent production of element 93 when uranium (element 92) was bombarded with neutrons. In fact, nuclear fission occurred in this process, leading to the emission of fragments half-way down the periodic table, but this surprising interpretation was not immediately evident. It was this surprising result of 'nuclear fission' that heralded in the atomic age, as the fission fragments carried away enormous amounts of energy.

Fermi's experiments with neutrons followed on from Rutherford's experiments in which elements were bombarded with alpha particles. However, in Rutherford's experiments, electrostatic repulsion between the positive alpha particle and the atomic nucleus tended to keep them apart, whereas in Fermi's experiments the neutron, being neutral, could freely enter the target nucleus.

In 1939, Fermi and his family left Italy for the USA after the award of the Nobel Prize. Fermi had visited the United States before and enjoyed the atmosphere there for physics. Fermi is described as being grateful to be leaving Italy because of the rise of Fascism and his wife Laura being Jewish. The offer of a position at Columbia University in New York was welcome.

At that time, the physics world was abuzz with the process of nuclear fission and the possibility of using it to build bombs of unprecedented power. Fears were high that physicists in Germany might be working toward this end. This led to efforts in the USA and the UK to consider the feasibility of building such bombs, and Fermi was recruited to lead the construction of the world's first nuclear reactor at Chicago University as part of the effort.

This is well described in the biography. It is said that Fermi was driven largely by his admiration of physics, whereas other physicists were more attuned to the war effort. In any case, with the entry of Japan into the conflict, these efforts were redoubled with a result the world knows only too well.

After the war, the Fermis moved to Chicago, but at the early age of 53, Enrico Fermi passed away after a short battle with cancer. As noted by Segrè and Hoerlin, he passed on a legacy for doing calculations in physics in one of two ways: one, and Fermi's preference, was to have a clear physical picture of the process being calculated; the other was to have a precise and self-consistent mathematical formalism.

Fermi died ten years before the quark model was proposed in 1964. It would have been very interesting to hear his viewpoint on this model – was it a clear physical picture, a self-consistent mathematical formalism, or something else? Sadly, we shall never know.

This reviewer confidently believes *The Pope of Physics* by Segrè and Hoerlin will make interesting and instructive reading for any student or historian of modern physics.