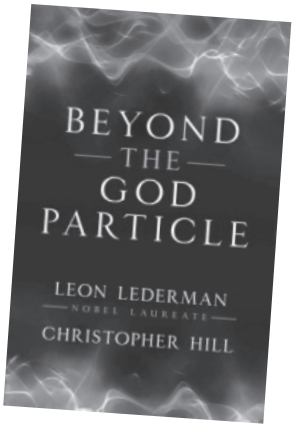
Beyond the God Particle

Reviewed by Roger D. Launius



Beyond the God Particle by Leon Lederman and Christopher Hill. Amherst, NY: Prometheus Books, 2013. 325 pages (acknowledgments, appendix, notes, index). $24.95 USD, ISBN: 978-1-61614-801-0 (hardcover with dust jacket).

It was hard to miss the story about finding the so-called "God Particle" when it broke on July 4, 2012. On that date scientists at the Large Hadron Collider (LHC) near Geneva, Switzerland, announced that they had found the long sought after Higgs boson. Less than a year later, on March 14, 2013, physicists at the European Organization for Nuclear Research, known as CERN, confirmed this discovery.

Presumably the Higgs boson subatomic particle is ubiquitous in the universe, forming a field that connects everything to everything. Hence the name that has been given to the Higgs boson, the "God Particle." It is the central element of all the elementary particles that provide the building blocks of the universe regardless of type or substance or longevity. So what does all of this mean? That, of course, is the subject of this book.

In an earlier book titled *The God Particle: If the Universe Is the Answer, What Is the Question?* (1993) Nobel Laureate Leon Lederman with Dick Teresi discussed the search for this connecting particle or particles, exploring the theoretical reasoning and experimentation that had been completed by 1993 to understand this baffling scientific problem. Also, in this book Lederman unapologetically labeled the Higgs boson the "God Particle" solely for marketing purposes. Twenty years later, Lederman, this time with coauthor Christopher Hill, note that the quest for the Higgs boson was half the fun, but the recent findings at LHC and CERN opens as many questions as they answer.

This new book, *Beyond the God Particle*, emphasizes what we now know about the physics of the Higgs field, explaining at length what particle physicists are presently doing, how they are accomplishing it, and why this effort is necessary for the future. The authors do a fine job of narrating LHC's and CERN's efforts to discover the Higgs boson, the importance of the boson in the cosmos, and offer a path forward for particle physics. This is not easy reading, however, Lederman and Hill do not hold back in terms of theoretical formulation, mathematical equations, and obtuse explanations. The authors wax eloquent about such little-known constructs as "the lowly muon," explained as an elementary particle that presuggested that the Higgs boson must exist.

They then explain how mass—explained as the amount of matter and not its weight—arose as the Higgs boson created a field to fill up the vacuum of the universe with a constant but exceptionally weak charge. Theorized for several years, these ideas drove the construction of the Large Hadron Collider and the use of this instrument—the most powerful and most expensive particle accelerator ever built—immediately paid off with the discovery of the Higgs boson.

Lederman and Hill go on to highlight several new questions, the answers to which they are convinced will revolutionize physics in the twenty-first century. These questions include: Why were scientists convinced that something like the "God Particle" had to exist? Why is so much of the matter in the cosmos "dark" and invisible to us? How will the discovery of the Higgs boson affect current models of reality like string theory and supersymmetry? These intriguing questions, and others like them, will fuel scientific research for years to come.

I was especially intrigued to a pet project of both Lederman and Hill. The Fermi National Accelerator Laboratory (Fermilab), located just outside Batavia, Illinois, has proposed a new instrument, called Project X, that would enable the study of rare decays, neutrino physics, potential muon storage rings, and the possibility of new sorts of fission reaction. This is a fascinating development, and the authors are unabashed in their support for this project not only for its scientific potential but also because of the need for the United States to recover from the knowledge losses suffered by the cancellation of the Super-colliding Super Collider and the European efforts at CERN and LHC. Lederman and Hill believe that the decisions on this effort will be made not later than 2017 and indeed must be taken by then or the U.S. will fall so far behind in physics that it may not be able to recover in the first half of this century.

While *Beyond the God Particle* is a chatty book, replete with anecdotes and reasonably understandable explanations, its merger of theoretical physics with the story of the Higgs boson discovery is less than seamless and sometimes awkward. Moreover, the authors' discussion of American politics is less than evocative. They bash the nation's political leadership for failure to pursue physics with the passion they believe exists in Europe. They lambast what they think of as the less than scientifically-literate public. They bemoan a political landscape that fails to appreciate the pursuit of science, which they contend is not just about the quest for knowledge but also is critical to the quest for new marketable technologies. Those discussions are both overly simplistic and fail to appreciate the rigors of formulation of science policy in the United States. Lederman and Hill write off this situation as so much political myopia, a sophomoric analysis if ever there was one.

Regardless, *Beyond the God Particle* is a quite useful, engaging, and potentially important discussion. It brings to the center of the current scientific enterprise the nature of the Higgs boson and its place in directing future efforts in physics.

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