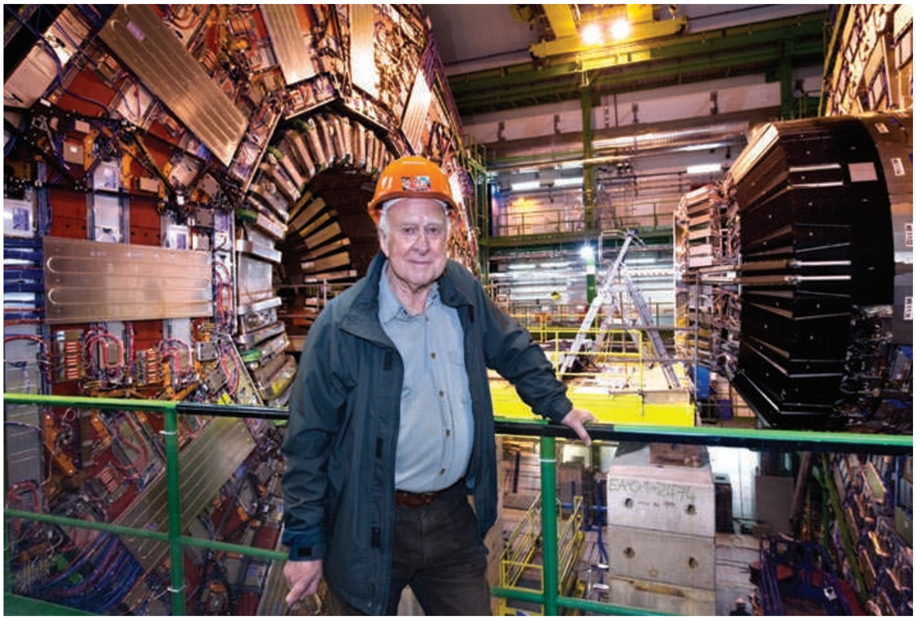
BOOKS & ARTS

How the boson got Higgs's name

Frank Close enjoys a journalistic account of the sociology and politics of the search for the elusive particle named after physicist Peter Higgs, but cautions that the idea has deeper roots than its name implies.

Massive: The Hunt for the God Particle
by Ian Sample
Virgin Books: 2010. 320 pp. £20



M. BRICE/CERN

Peter Higgs recognized the importance of the 'God particle', which the Large Hadron Collider aims to find.

To many, the Large Hadron Collider (LHC) is synonymous with Peter Higgs, the physicist after whom the particle accelerator's primary target — the Higgs boson — is named. In *Massive*, science journalist Ian Sample describes Higgs's work and the experimental search for this putative subatomic particle.

The LHC is the biggest experiment in physics. Located at CERN, Europe's particle-physics laboratory near Geneva, Switzerland, it aims to recreate the conditions of the Universe a trillionth of a second after the Big Bang. From this we hope to learn how matter was formed, and how the structures on which life depends emerged. Widespread coverage of this huge project has led many to believe that in finding the Higgs boson, as the book jacket states, we "will finally understand the origins of mass — the last building block of life itself".

Sample describes the competition and politics behind the experiments that have sought the eponymous boson. He covers the building of the LHC and its forerunner, the Large Electron Positron Collider, and the political manoeuvres in the United States that led to the birth of its challenger — the Superconducting Super Collider (SSC) — and then killed it in 1993. He relates amusing anecdotes, such as how Alvin Trivelpiece, then director of energy research at the US Department of Energy, convinced President Ronald Reagan to support the SSC in 1987 by telling him that Fermilab in Batavia, Illinois, was not 50 miles west of Chicago but 50 miles east of Dixon, near the former president's birthplace.

Sample spins a good yarn but he gives the false impression that the search for the Higgs boson has been central to particle physics since its prediction in the 1960s. The real story is more subtle.

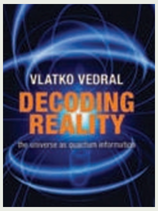
Higgs is made out to be a hero, which will be uncomfortable to some. Sample recognizes that others worked on aspects of the idea for generating mass, but does not explain why Higgs alone is now associated with the boson. Even though particle physicists hate its media label of 'God particle', many argue that it should not be called the Higgs boson because the concept has a longer history. Higgs himself modestly refers to the entity as "the boson that's been named after me". In apportioning credit, Sample misses the nub.

Massive perpetuates the shibboleth that "three groups of physicists, working independently in different countries, stumbled upon an idea that would change physics" — namely the Higgs boson. The three groups comprised Robert Brout and François Englert in Belgium; Peter Higgs in Scotland; and Tom Kibble in London with his two US colleagues, Gerald Guralnik and Carl R. Hagen. Within a few weeks of each other in 1964, and in that order, these teams independently showed how the particle carriers of forces — such as a photon — could gain mass as a result of spontaneous breaking of fundamental symmetry. Whereas the W and Z bosons that carry the weak force make use of this mechanism, the photon that carries the electromagnetic force does not; it remains massless. Why this happens remains unanswered.

Yet this mechanism is not the Higgs boson. Although the idea has been used to assign masses for the electron and quarks, it does not explain the bulk of matter's mass, which is located in the atomic nucleus and arises because of a different phenomenon — quark confinement, which prevents the quarks that make up protons and neutrons from existing singly in isolation. Consequently, protons and neutrons are much heavier than the quarks within them, the quarks contributing only about one per cent of the whole, as Sample mentions briefly. The mechanism's significance is that, in giving a mass to the W boson, it enfeebles that fundamental force. This weakening has slowed the Sun's nuclear fusion reactions sufficiently to allow five billion years of sunlight — enough time for evolution to occur. And in giving mass to the electron, the mechanism gives a size to atoms.

Behind all this theory lies the work of another British physicist, Jeffrey Goldstone. In his investigation of spontaneous symmetry breaking in 1961, Goldstone identified two bosons that played a part: one was massive, the other massless. Both differed from the photon or W boson in that they lacked the intrinsic quantum property of spin. Empirical evidence indicated that the massless Goldstone boson does not exist, flagging up a theoretical quandary that received much attention at the time from those who hoped to use the theory as a basis for uniting the weak and electromagnetic interactions. The mechanism discovered by the three groups of physicists in 1964 explained how Goldstone's massless boson could disappear, in the process giving a mass to the W boson that transmits the weak force. It thus solved two problems for the

BOOKS IN BRIEF



The Universe is an intangible sea of information, suggests physicist Vlatko Vedral in his book *Decoding Reality* (Oxford Univ. Press, 2010). Everything around us can be explained through ephemeral statistics. Moreover, much of modern physics, he says, is attributable to the fact that information can be created out of nothing. Vedral challenges our concepts of matter, time, determinism and reality — from the concepts of entropy in thermodynamics to quantum entanglement, and from advances in quantum computing to the Universe itself.

Tech Transfer (CreateSpace, 2010) marks the first foray into fiction for veteran science-policy reporter Daniel Greenberg. Writing of research life at the mythical Kershaw University, he pokes fun at the machinations of academic institutions. As the book's feuding faculty members plot to disguise their somnolence and to profit from spin-off companies and unethical research, cheating students party on campus. Greenberg's exposé is tongue-in-cheek and his portrayal harsh, but his messages are serious.

More than 80 richly detailed maps of worldwide environmental data are presented in *The Atlas of Global Conservation* (Univ. California Press, 2010). This compilation is written and edited by Jennifer Molnar of The Nature Conservancy and her colleagues, along with journalist Katherine Ellison. The collection highlights the geographical variation of the effects of climate change, water use, habitat protection, deforestation and overfishing, conveyed by sophisticated graphics and informative text.

price of one, and paved the way for the modern theory of the 'electroweak' force.

Sample recognizes this work but overlooks its massive counterpart, which is where the excitement lies today. The irony is that it also went largely ignored in 1964. Brout and Englert made no mention of it in their paper, although they were aware of its manifestation in condensed-matter physics. Guralnik, Hagen and Kibble suppressed it in their analysis, which was simplified to focus on the removal of its massless companion. Higgs alone pursued it. What is being called Higgs's boson is, in effect, Goldstone's massive boson. Although at least six physicists can lay claim to this particular mechanism for generating mass, only Higgs realized the importance of the massive boson in testing the theory.

If the above mechanism gives mass to fundamental particles — whether they are the massive W and Z bosons; leptons such as the electron or the heavier muon and tau; or even the various flavours of quarks, from lightweight up and down to heavy top, by way of the middleweight charm and bottom — it will be the decay pattern of the Higgs boson into these various particles that will prove it. According to the theory, the Higgs boson will tend to produce the massive flavours of a given family more readily than their lightweight counterparts. It is this pattern that the LHC seeks.

This historical subtlety has given rise to some confusion in nomenclature between the misnamed 'Higgs mechanism' and the Higgs boson itself. The mass-conferring mechanism is the one proposed by the three groups independently, and was anticipated by US physicist Philip Anderson in 1963. The Higgs boson was named by physicists in recognition of Higgs's work on the particle, despite its origins in Goldstone's theory.

To get a sense of the sociology and politics of high-energy physics, *Massive* is a good place to start. However, if you are assessing competing claims for a Nobel prize, or need to understand the relationship between the widely misattributed Higgs mechanism and the boson that carries his name, be careful. ■

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Earth-shaking images

The Illustrated History of Natural Disasters
by Jan Kozák and Vladimír Čermák
Springer: 2010. 231 pp. $89.95, £49.99

Catastrophist ideas have seen a resurgence since the 1980s, when geologist Walter Alvarez associated the dinosaurs' disappearance with an asteroid impact. The sense that cataclysmic events shape the planet has been reinforced by a string of recent natural disasters — the 2004 Indian Ocean earthquake, Hurricane Katrina in 2005 and the 2010 Haiti earthquake. Even minor geophysical events can disrupt populations, as the current Icelandic volcanic ash cloud demonstrates.

The Illustrated History of Natural Disasters, by geophysicists Jan Kozák and Vladimír Čermák, is a timely collection of pictorial records of earthquakes, volcanoes and tsunamis from antiquity to modern times. It shows how such events — and the way they were illustrated — influenced the development of geoscience. Accompanied by explanatory text, the images include copper engravings, woodcuts and oil paintings, produced for purposes ranging from scientific observation to newspaper reporting. The result is a hybrid book that intertwines the history of science and art.

The authors focus on Italian volcanoes, which

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Vesuvius erupting in 1794.

were particularly influential. Mount Vesuvius, which buried in ash the cities of Herculaneum and Pompeii in 79 AD, became a natural laboratory for geologists when it resumed activity in the mid-seventeenth century. William Hamilton, the British ambassador who lived in Naples from 1764, devoted himself to studies of Vesuvius, including monitoring the increasing frequency of eruptions during the second half