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Celebrity at stand-up reception

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He predicted the existence of “his” particle back in 1964: British physicist Peter Higgs. Credit: CERN

Higgs or not Higgs? That is the question, of course. Physicists nevertheless already consider finding the new particle - whatever it may be – to be one of the most important discoveries of recent decades. If it does turn out to be the particle predicted by British physicist Peter Higgs, which some in the media are calling the “God Particle”, this would then be the last piece of the puzzle. And the standard model of elementary particle physics would be gloriously confirmed.

The 4th July 2012 was probably the most exciting day in Peter Higgs' life. Because on that morning, scientists at the European Nuclear Research Centre CERN announced that they had probably found the particle which bears his name. The 83-year-old Higgs had actually come to CERN in Geneva and was fêted there like a rock star.

Four of his colleagues also have reason to be happy - for although Peter Higgs is the person after whom it is named, the scientist was not on his own in predicting the existence of the particle in 1964: Francois Englert and Robert Brout in Brussels, and Gerald Guralnik, Carl R. Hagen and T.W.B. Kibble at Imperial College in London also postulated its existence independently of Higgs and at about the same time; Brout died in May 2011.

What gives elementary particles their mass? This question, which seems so simple at first sight, is one of the greatest mysteries of physics. Higgs and his colleagues provided an answer: a new particle. Or to be more precise, it is not the particle itself, but a field - also called Higgs mechanism - which explains the mass. The “Higgs” is inseparably bound up with this field. The theory says it is a member of the boson family. These have integral spin (which can be roughly understood as a rotation) and mediate the forces between the particles of matter.

The Higgs boson has zero spin, but it mediates a force rather than mass. Since this is difficult to imagine, physicists like to explain it with an example from daily life. The current events at CERN mean it can even be told with Peter Higgs as the protagonist: imagine a reception for particle physicists. Everyone is standing around, engrossed in conversation, with a glass of champagne in their hand; they are grouped loosely together and distributed more or less uniformly across the room. Now Peter Higgs enters the room - and the guests immediately begin to congregate around him. The celebrity quite literally lends “weight” to the event - and his particle does the same to the particles of matter.

For nearly five decades the Higgs boson has been an elementary constituent of the standard model, which describes the elementary particles and their interactions. This model comprises six quarks (up, down, charm, strange, top, bottom), six leptons (electron, muon, tau and their neutrinos) and four gauge bosons (photon, gluon, W and Z boson).

Years of experiments have enabled theoreticians to calculate the mass that the neutrally charged Higgs particle would have to have: the mass of 100 to 200 protons, that is to say the positively charged basic building blocks of the nucleus. Since mass and energy can be converted into each other according to Einstein's famous equation ($E = mc^2$), physicists often express the mass in terms of energy. The mass of one proton then corresponds to an energy of one gigaelectronvolt (GeV). Which means: the energy range predicted for the Higgs boson should be between 100 and 200 GeV.

In recent years, researchers have narrowed down the energy range more and more with their experiments – some of which were carried out at the Large Hadron Collider at CERN. At the beginning of 2012 they were quite certain: Higgs must be in a narrow range between 120 and 130 GeV. Now the scientists have determined an approximate measured value of 125 to 126 GeV for their particle - which fits wonderfully with the theoretical prediction.

In reality, it is of course not that easy to determine this kind of data. The 27-kilometre ring tunnel of the Large Hadron Collider is similar to a gun in which two proton beams moving in opposite directions are fired at each other. The result of these collisions: cascades of myriads of explosion fragments and newly formed particles. Now the task is to separate the wheat from the chaff - and filter out the known from the unknown particles. Among the quadrillion of registered events, only one ultimately arouses the interest of the physicists.

The CERN researchers are still not absolutely certain whether the tiny deflections they have now found in the measured curve actually conceal the Higgs particle, or whether they have even found the herald of a new physics. Whatever the outcome: Peter Higgs relished the ovations - and was moved to shed a tear or two.

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