

ENERGY & MASS

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Physicists Anxiously Await New Data on ‘God Particle’

High noon is approaching for the biggest manhunt in the history of physics. At 8 a.m. Eastern time on Tuesday morning, scientists from CERN, the European Center for Nuclear Research, are scheduled to give a progress report on the search for **(((the Higgs boson))))** — infamously known as the “God particle” — whose discovery would vindicate the modern theory of how elementary particles get mass.



One station of the CMS Endcap Muon chambers built by a collaboration of US institutions, which play a major role in the triggering of the CMS detector.

QUESTIONS: (a) Confirm the mass of protons and electrons in electron volts (listed below at the end of this article)? **HINTS:** $E = mc^2$, $m_{\text{electron}} = 9.11 \times 10^{-31} \text{ kg}$, $c = 3 \times 10^8 \text{ m/s}$, $m_{\text{proton}} = 1.6 \times 10^{-27} \text{ kg}$, $1.6 \times 10^{-19} \text{ Joules/ev}$ (electron volts).

(b) Find mass of the 114.4×10^9 (GEV) electron volt(ev)Higgs Boson(particle) in kg? **HINT:** $E = mc^2$ thus $m = E/c^2$

ANSWERS: (a) see below at bottom of page) , (b) $2.03 \times 10^{-25} \text{ kg}$.

The report comes amid rumors that the two competing armies of scientists sifting debris from hundreds of trillions of proton collisions in CERN’s [Large Hadron Collider](#), or L.H.C., outside Geneva, have both finally seen hints of what might turn out be the elusive particle when more data is gathered next year.

Alternatively, the experimentalists say that a year from now they should have enough data to rule out the existence of the most popular version of the **Higgs boson**, sending theorists back to their blackboards in search of another explanation of why particles have mass. So the whole world will be watching. Among them will be Lisa Randall, a Harvard particle theorist and author of the new book “Knocking on Heaven’s Door: How Physics and Scientific Thinking Illuminate the Universe and the Modern World.” In an interview with Dennis Overbye of The Times, Dr. Randall provided this guide to the action for those of us in the bleachers.

Q. What is the Higgs and why is it important? **A.** The name Higgs refers to at least four things. First of all, there is a Higgs mechanism, which is ultimately **(((responsible for elementary particles’ masses.)))** This is certainly one of the trickier aspects of particle physics to explain, but essentially something like a charge — not an electric charge — permeates the vacuum, the state with no particles. **(((These “charges” are associated with a Higgs field. As particles pass through this field they interact with the “charges,” and this interaction makes them act as if they had mass.)))** Heavier particles do so more, and lighter particles do so less. The Higgs mechanism is essential to the masses of elementary particles. The Higgs particle, or Higgs boson, is the vestige of the simplest proposed model of what created the Higgs field in the first place. Contrary to popular understanding, **(((the Higgs field gives mass — not the Higgs boson.)))** But a discovery of the Higgs boson would tell us that **(((the Higgs mechanism)))** is right and help us pin down the theory that underlies both the Higgs mechanism and the [Standard Model](#). In the simplest implementation of the Higgs mechanism, the experimental consequence is **(((the Higgs boson. It is the particle that the experimentalists are now searching for.)))** Of course, Higgs is also the name of the person, Peter Higgs, who first developed the underlying theory (along with five others who will be in contention for the [Nobel Prize](#) if and when the Higgs particle is discovered.)

Q. What do we know about it so far? **A.** Experimenters have already ruled out a large range of masses. The Higgs boson, if it exists, has to be heavier than **(((114.4 giga-electron volts (GeV))))**, which are the units of mass that particle physicists use. By comparison, **(((protons, the bedrock of ordinary matter, are about 1 giga-electron volt, and an electron is only half a million electron volts))))**.