Planungsblatt Physik für die 6B

Woche 38 (von 08.06 bis 12.06)

Aufgaben & Aufträge [1]

Bis Dienstag 09.06:

Dienstag am Nachmittag bin ich bei der mündlichen Matura.

Bis Donnerstag 11.06:

Die Sonne strahlt, weil es Kernfusion im Sonneninneren gibt! Im Inneren verschmelzen Protonen zu Helium- und sogar Kohlenstoffkerne. Dabei kommt viel Energie frei, auch in Form von Röntgenstrahlung. Diese Strahlung erhitzt das Material in der Sonne und somit ist es im Sonneninnneren um die 10 bis 20 Million Kelvin, an der Oberfläche so knapp unter 6000 Kelvin. **Aufgabenstellung**: Ist die Sonne als Lichtquelle besser mit Feuer oder mit glühendem Stahl zu vergliechen? Begründe deine Antwort!

Bis Montag 15.06:

Keine HÜ.

Kernbegriffe dieser Woche:

CMBR, Sterne, thermische Strahlung

Ungefähre Wochenplanung

Schulübungen.

- **(a)** Montag: (i) HÜ-Bespr. (ii) Erklärung Big Bang: Wie sieht man den Urknall noch? CMBR! Und was das ist, dann muss ich aber thermische Strahlung erklären …
- **(b)** Dienstag: Diese Stunde wird wohl ausfallen, denn ich bin bei der mündlichen Matura!
- **(c)** Donnerstag: (i) HÜ-Bespr. (ii) Standardmodell: Was ist es? Was erklärt es? Was ist LHC? Warum tun wir solche Experimente? Was ist die gesellschaftliche Relevanz? Die Fragen müsst ihr beantworten, ich erkläre etwas :-) (iii) Text zum Higgs-Boson lesen!

Unterlagen auf `www.mat.univie.ac.at/~westra/edu.html`

What is the Higgs boson and why does it matter?

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[1] Für manche Aufgaben wird auf Rückseite/Anhang/Buch/Arbeitsblatt verwiesen.

12:26 13 December 2011 by Lawrence Krauss For similar stories, visit the The Higgs boson and The Large Hadron Collider Topic Guides A version of this piece was originally commissioned by the Richard Dawkins Foundation for Science and Reason and also appears on their website RichardDawkins.net.

As the world awaits news of the possible discovery of the Higgs boson, there remains a lot of confusion about what it is, why we have had to work hard to find it and why we should care. Here's why.

First, the short answer:

If the Higgs is discovered, it will represent perhaps one of the greatest triumphs of the human intellect in recent memory, vindicating the construction of one of science's greatest theories and the most complicated machine ever built. That's the good news.

But if the Higgs is all that is found at the Large Hadron Collider (LHC), a huge amount will remain to be discovered. Crucial experimental guidance that physicists need to understand fundamental questions about our existence from whether all four forces in nature are unified in some grand theory to determining what may have caused the big bang will still be absent. Answering these questions may be beyond our technical and financial capabilities in this generation.

Now for the long answer:

If our ideas about the Higgs boson turn out to be correct, then everything we see is a kind of window dressing based on an underlying fabric of reality in which we shouldn't exist. The particles that make us up which bind together to form protons, neutrons, nuclei and ultimately atoms have mass. Without the Higgs, these particles would be massless, like photons.

We all know from our own experience that how heavy something feels depends on where it is located. For example, objects that are heavy on land appear lighter in water. Similarly, if you try to push a spoon through treacle it appears heavier than if you push it through air.

The standard model of particle physics implies that there is a ”Higgs fieldthat permeates all space. This field interacts with particles, and does so with varying strengths. Particles that interact more strongly experience more resistance to their motion and appear heavier. Some particles, such as photons, do not interact with the field at all and remain massless.

In this way, the mass of everything is determined by the existence of the field, and mass is an accident of our circumstances because we exist in a universe in which such a background field happens to have arisen.

Playing subatomic catch

But why a Higgs particle? Relativity tells us that no signal can travel faster than light. Incorporating this into quantum mechanics tells us that forces which we think of as being due to fields are actually transmitted between objects by the exchange of particles. The way particles transmit forces is a bit like a game of catch: if I throw a ball and you catch it, I will be pushed backwards by the act of throwing and you will be pushed backwards by the act of catching. Thus we act as if we repel each other.

So if there is a Higgs field, it turns out that there has to be a particle associated with this field, and this is the Higgs particle.

This seems a fanciful framework, rather like imagining angels on the head of a pin. What would drive scientists to imagine such a scenario? One of the greatest successes of the past 50 years was the unification of two of the forces of nature: electromagnetism and the weak interaction. In this ëlectroweaktheory, electromagnetic forces arise by the long-range exchange of massless photons, and the short-range weak force is due to the exchange of massive particles called W and Z particles, predicted in the 1960s and discovered in the 1980s at CERN, the European particle physics laboratory near Geneva, Switzerland, which is now the home of the LHC.

In order for this theoretical unification to make mathematical sense, all three particles have to be massless in the underlying theory, and therefore the forces they mediate would be almost identical. Only if the W and Z particles obtain a mass by interacting with a background field the Higgs field will the underlying unified theory explain why the two forces appear different at the scales we measure them today, while remaining mathematically consistent.

High mass

Theory suggests that the mass of a Higgs particle should be about 100 times the mass of the proton; however, the exact mass is not predicted.

For over 25 years since the discovery of the W and Z particles, experimental physicists have been trying to build particle accelerators with the energy necessary to produce a Higgs particle, if it exists. The Tevatron accelerator at Fermilab in Batavia, Illinois, was able to reach up to about 120 times the mass of the proton (about 120 gigaelectronvolts) but did not find the Higgs.

The LHC was designed to probe for Higgs masses heavier than this. If the Higgs particle is announced with a mass of 125 GeV, as the rumours suggest, it will be the crown jewel of our theoretical understanding of the electroweak unified theory, our own origins and the origin of almost all mass we measure in the universe.

Not just the Higgs, please

All is not that rosy, however. The standard model gives no explanation of the masses of the Higgs, the W and Z. Indeed, other arguments suggest that we need new physics to explain why quantum mechanical effects should not make this scale of masses is not much higher.

One of the most exciting ways in which this behaviour might be kept in check involves a theory called supersymmetryMovie Camera. If supersymmetry is real, the number of elementary particles would double, and we would need not one Higgs particle but two. This is what many physicists have expected to find. The rumours from CERN suggest a second particle at about 140 GeV.

Since supersymmetry is an essential ingredient of the more speculative string-theory models that attempt to unify gravity and quantum mechanics, there is even more reason for some theorists to hope that either two Higgs particles, or even unsuspected particles, might be discovered.

If a single Higgs and nothing else is discovered at the LHC it will therefore be a mixed blessing perhaps the worst possibility we theorists can imagine. We will have discovered the origin of mass, as advertised, but there will be no new experimental guidance on how to take the next step.