The UK contribution

The UK is playing a leading role in the LHC and its experiments. The project leader during the construction of the LHC was Wolfgang Luhn, and groups from 19 British universities and research laboratories are taking part. They have designed, manufactured and assembled detector modules and developed new computing techniques to analyse unprecedented amounts of experimental data.

Nobel Prize

In 1964, Peter Higgs and others predicted the existence of an all-pervading field that gives mass to matter particles. Excitation of this field gives rise to the long searched for Higgs particle. In 2013 the Nobel Prize for Physics was awarded to Professor Peter Higgs and Professor François Englert for this theoretical discovery.

Professor Peter Higgs
University of Edinburgh

International collaboration

The LHC is at CERN, the European Laboratory for Particle Physics, in Geneva. Thousands of physicists and engineers from over 113 countries across the world work on various aspects of the project, both at CERN and in their home countries. The experiments require carefully planned cooperation between many multinational teams. Many components of the detectors were constructed in one country, then assembled and tested in another, before being sent to CERN. UK industry was involved in making many of the components and still contributes to on-going experiments and upgrades.

What happened in the big bang?

QUARKS, GLUONS AND THE BEGINNING OF THE UNIVERSE

At the earliest moments of the Big Bang, the Universe consisted of a eerily hot soup of fundamental particles - quarks, leptons and the force carriers. As the Universe cooled to 10^9 degrees, the quarks and gluons (carriers of the strong force) combined into composite particles like protons and neutrons. The LHC is able to collide heavy nuclei so that they release their constituent quarks, taking us back to the time before the protons and neutrons formed, and re-creating the conditions when quarks and gluons were free to mix without combining. The ALICE experiment studies the debris of these collisions to investigate this early state of matter.

Why do particles have mass?

MYSTERIOUS MASS

Particles of light (known as photons) have no mass. Fundamental particles (such as electrons and quarks) do—and we’re not sure why. British physicist Peter Higgs proposed the existence of a field which pervades the entire Universe and interacts with these particles to give them mass. This field should reveal itself as a particle – the Higgs Particle. The discovery of a Higgs-like particle was announced on 4th July 2012 by the ATLAS and CMS teams.

Where’s the antimatter?

MATTER AND ANTIMATTER

Every fundamental matter particle has an antimatter partner with equal but opposite properties such as electric charge. For example, the negative electron has a positive partner known as the positron. Antimatter was created, along with matter, in equal amounts in the Big Bang, but we see mostly matter in the Universe today - so what happened to the antimatter? Experiments have already shown that some particles decay at slightly different rates from their anti-particles, which could explain this. The LHC’s experiment studies the subtle differences between matter and antimatter particles.

What’s the Universe made of?

DARK MATTER, NEW PARTICLES AND SUPERSYMMETRY

The theory of "supersymmetry" suggests that all known particles have, as yet undetected, "superpartners". If they exist, the LHC should find them. These "supersymmetric" particles may help explain one mystery of the Universe – dark matter. Astronomers detect the gravitational effects of large amounts of matter that can't be seen. This dark matter is estimated to make up about 85% of the total matter in the Universe and we don’t know what it is! One possible explanation of dark matter is that it consists of supersymmetric particles.

What kind of universe do we live in?

EXTRA DIMENSIONS AND MINI-BLACK HOLES

Gravity does not fit comfortably into the current descriptions of forces used by physicists. It is also very much weaker than the other forces. One explanation is that extra, undiscovered dimensions exist in our Universe and that gravity can "leak out" across the dimensions, making it appear weaker. The LHC may enable us to observe some evidence of these extra dimensions – for example, the production of mini-black holes which exist for just a tiny fraction of a second.
BIG QUESTIONS: BIG EXPERIMENT
THE LARGE HADRON COLLIDER, CERN

The Universe started with a Big Bang – but we don’t fully understand how or why it developed the way it did. The Large Hadron Collider allows us to see how matter behaved in the first tiny fraction of a second. We have some idea of what to expect – but also expect the unexpected!

WHERE’S THE ANTIMATTER?
Yes, antimatter is real and the LHC can make it! Both matter and antimatter were created in the Big Bang, but we see mostly matter now. What happened to the antimatter?

WHY DO PARTICLES HAVE MASS?
Why do some particles have mass while others don’t? What makes this difference? The discovery of the Higgs Particle helps us understand this.

WHAT IS OUR UNIVERSE MADE OF?
96% of our Universe is missing. Some of it may be stuff that scientists call ‘dark matter’. Can the LHC find it?

WHAT KIND OF UNIVERSE DO WE LIVE IN?
Many physicists think the Universe has more dimensions than the four (space and time) we are aware of. The experiments at the LHC are looking for evidence of new dimensions.

WHAT HAPPENED IN THE BIG BANG?
What was the Universe made of before the matter we see around us formed? The LHC can recreate the conditions existing during the first billionth of a second after the big bang.