Chapter 3 Radioactivity and radiation

Teacher Notes

Module 3.2 Radioactivity

Evaluation and Analysis 3.2.2 **Media response:** Crash collider destroys universe

Dr Karl looks at the Large Hadron Collider and at the chances of us all being sucked into a black hole of our own making.

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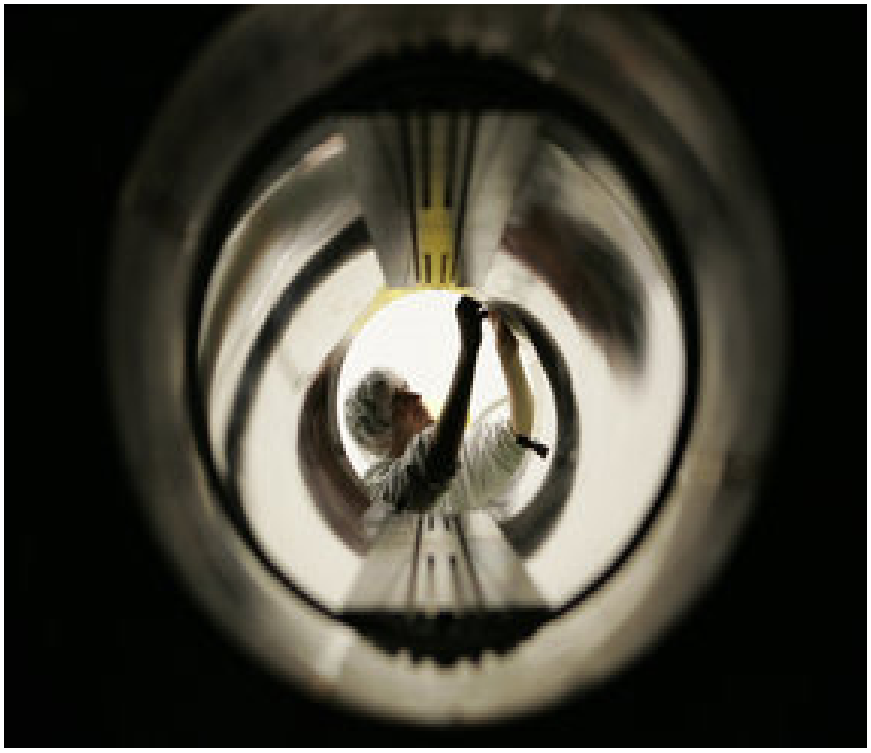

A technician assembles the tracker of the magnet core of the Compact Muon Solenoid, a 1920-tonne element at CERN, March 22, 2007. CMS is part of five experiments that will study what happens when beams of particles collide in the 27 km-long underground Large Hadron Collider (Source: Denis Balibouse/Reuters)

Back in the old days before terrorists and tsunamis, it was always the labcoat-wearing mad scientists who were going to destroy the Earth in one of their crazy experiments. In the movies, scientists were always the ideal scapegoats—bald apart from two tufts of hair, certifiably mad, and without a friend in the world. Well, scientists are back in the firing line again. As the Large Hadron Collider (LHC) in Europe begins operations, there is a paranoid groundswell telling the world that this science experiment will unleash uncontrollable forces, wreck the planet and kill us all.

The LHC has actually been designed to answer some of the big questions in physics, such as, what is mass. There are so many questions. For example, think about some of the sub-atomic particles, such as electrons and quarks. They are just points—they have no size. And in between them, there is a vacuum. So these sub-atomic particles are mathematical figments floating in nothing. Even worse, these mathematical figments have weird properties like charge, and mass. The LHC, which was switched on in late 2008, will help solve some of these crazy mysteries. To do this, it will recreate some of the titanic energies found immediately after the Big Bang.

The Large in LHC is not an exaggeration—it's enormous. It's an underground tunnel, shaped like a ring, that straddles the borders of Switzerland and France. Over 2500 scientists from 37 countries are labouring to build just one of its four detectors—which by itself, has more iron than the Eiffel Tower. The LHC will generate so much raw data that if it were stored on CDs, the stack would grow at 1.6 kilometres per month. The project will employ about half of all the particle physicists in the world.

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Its name tells you what it does. 'Hadrons' are microscopic particles (such as the protons in the core of an atom) that can interact with regular matter. Protons, for example, have a positive charge, and this makes them relatively easy to manipulate. The LHC will collide beams of protons together. And hopefully the products of the collision will include the long sought after Higgs Particle, which is thought to endow everything in the universe with the strange property we call 'mass'.

The protons will travel at 99.99991% of the speed of light through pipes 27 kilometres in circumference, buried 50–100 metres underground. At that speed, the protons will have the energy of an express train. They will be kept travelling in a curved path by the largest array of superconducting magnets ever built, cooled by 130 tonnes of liquid helium. The liquid helium will be colder than the temperature of deep space.

You've probably heard that mass and energy can be turned into each other. In a nuclear weapon, a small amount of mass is turned into a huge amount of energy. In the LHC, the opposite happens—energy is turned into mass. In a bizarre example of how mass and energy can be interchanged, two small fast-moving protons will collide to make much-heavier slower particles—as though two nippy Cessna planes collided to make a lumbering bus. The energy in the 'speed' of the protons will hopefully be converted to the mass of the Higgs Particle.

Over the last decade, uninformed scare-mongers have spread disaster scenarios, with the LHC destroying the Earth, and even the universe. They say (quite correctly) that it's theoretically possible for the LHC to create mini-black holes. They then conveniently ignore the rest of the same theory that points out that the black holes would evaporate almost immediately. Instead, they wrongly claim that the mini-black holes would rapidly eat the Earth.

The scaremongers also claim that the colliding protons in the LHC have enormous energies, and so something totally unforeseen in our current theories might happen. Well, cosmic rays with energies many tens of millions of times greater than the speeding protons in the LHC have been smashing into all the planets and moons in our solar system for billions of years - and we're all still here. So let's give it a whirl, and see what we find.

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Questions and answers

1 What does LHC stand for?
Large Hadron Collider

2 Protons and neutrons are known as hadrons. What are hadrons?
Microscopic particles (such as the protons in the core of an atom) that can interact with regular matter.

3 Hadrons are composed of smaller particles known as quarks. Do a web search to find out the six varieties of quarks.
The six 'flavours' or varieties of quarks are Up, Down, Charm, Strange, Top and Bottom.

4 **a** Which subatomic particle is being accelerated around the LHC?
Protons

b What speed does it reach?
99.99991% of the speed of light

c What change occurs to these particles as their speed increases?
As the protons are accelerated they gain energy. At near the speed of light the protons will have the energy of an express train.

d Neutrons are just as massive as these particles but cannot be used in particle accelerators. Why can't neutrons be accelerated around the LHC?
Neutrons can't be accelerated around the LHC because they don't have a charge. Protons are used because they are positively charged, which makes them easy to manipulate.

5 What is the name of the particle that the physicists are hoping to find? Why is this particle thought to be of importance?
Physicists are hoping to find the Higgs Particle. The Higgs Particle is thought to endow everything in the universe with mass.

6 Do a web search to determine whether the Higgs Particle has been found yet.
The Higgs particle was discovered in 2012 through the use of the LHC. In 2013, François Englert and Peter W. Higgs were awarded the Nobel Prize in Physics for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which was recently confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider.

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