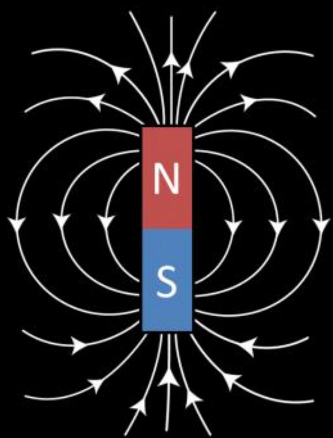
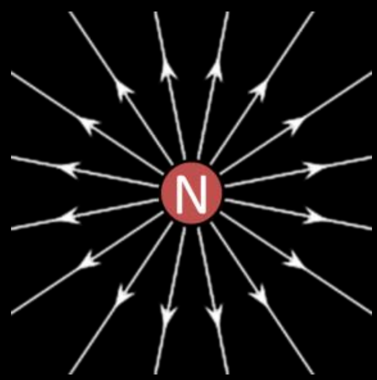
What is a magnetic monopole?

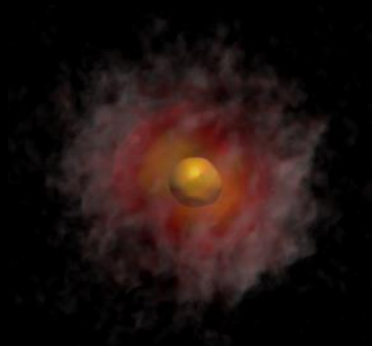


Magnets always have two poles, north and south. Or do they?

Could there be *magnetic monopoles*, particles with a single north or south pole?

The existence of magnetic monopoles would make electromagnetism more symmetric, because then the electric and magnetic fields would behave in the same way. This is called *electromagnetic duality*.

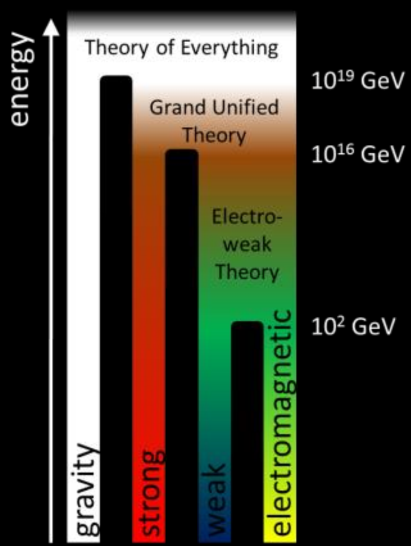




Computer simulation of a magnetic monopole

Magnetic monopoles are only compatible with quantum physics if electric charge is *quantised* (which indeed seems to be the case!)

If magnetic monopoles exist, their *magnetic charge* has to be very strong: inversely proportional to the smallest electric charge. The force between two magnetic monopoles would be 4700 times as strong as the force between two electrons



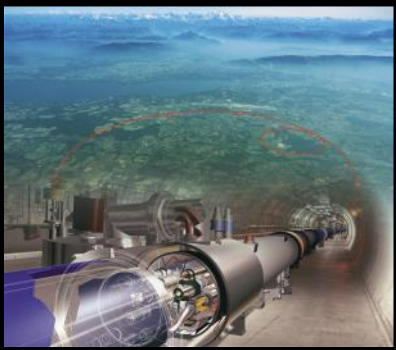
Magnetic monopoles are predicted by *Grand Unified Theories*, which attempt to describe all elementary particle forces in terms of a single unified force, and by superstring theory.

MoEDAL CERN Imperial College London King's College London University of Alberta StarCentre selected The Royal Society Summer Science Exhibition 2015

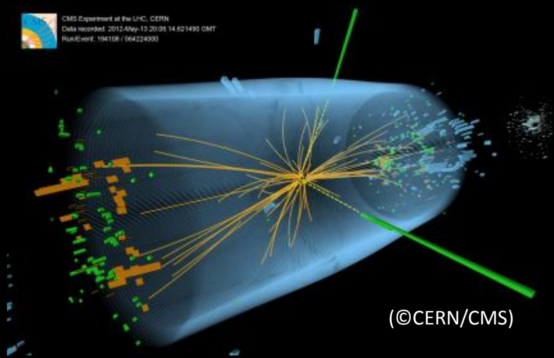
Twitter: @MonopoleQuest #MonopoleQuest

Web: http://www.liftapp.ac.uk/MonopoleQuest

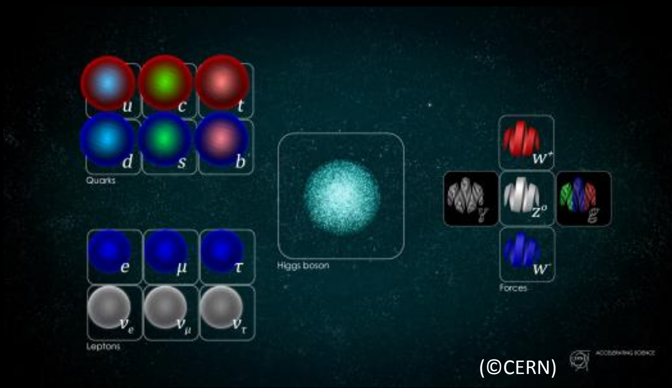
The Large Hadron Collider



The Large Hadron Collider (LHC) is the largest *particle accelerator* in the world. It has a circular 27-kilometre tunnel, where two beams of protons travel in opposite directions at 99.999999% of the speed of light. When they collide head-on, the energy of the collision produces a large number of particles. Among them could be pairs of monopoles of opposite polarity.


(©CERN/CMS)

In 2012, two LHC experiments, CMS and Atlas, discovered the *Higgs boson*. It was the last elementary particle predicted by the Standard Model of particle physics to be discovered. Therefore this confirmed the theory.



(©CERN)

Since 2013, the LHC has been *upgraded* to double the energy it can reach to 13 teraelectronvolts. The upgrade was completed in spring 2015, and the second science run of the LHC started on 3 June 2015.

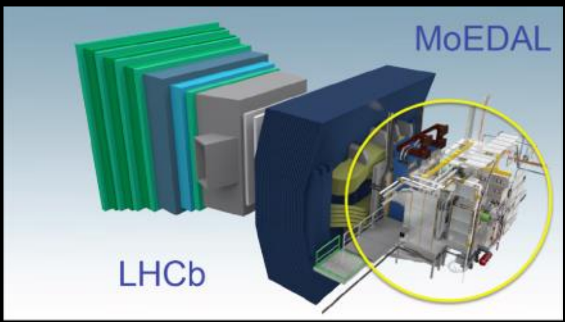
Now that the Standard Model has been confirmed, physicists are no longer looking for one specific particle. Instead, they hope that the higher energy will allow them to find new particles, for example *magnetic monopoles*. Therefore the LHC now has a new experiment called MoEDAL, which has been designed for this purpose.

Twitter: @MonopoleQuest #MonopoleQuest

Web: http://www.liftapp.ac.uk/MonopoleQuest

MONOPOLE QUEST

The MoEDAL experiment



The Monopole and Exotics Detector at the LHC (MoEDAL) is a new experiment searching for magnetic monopoles produced in proton-proton collisions. The experiment started operation on 3 June 2015, and shares the LHC Intersection Point 8 with the LHCb experiment.

The MoEDAL experiment consists of three main components:

- *Nuclear Track Detectors* are stacks of plastic sheets, placed around the collision point. If a magnetic monopole flies through the detector sheet, it damages the plastic. The exposed sheets are etched in chemicals, which turns the damaged area into a conical pit. The sheets are then scanned and analysed with the help of a Zooniverse citizen science project. This means that YOU can discover the magnetic monopole!

- *Trapping Detectors* are aluminium bars. MoEDAL has approximately 800kg of them placed behind the trapping detectors. A magnetic monopole flying through the aluminium slows down and can get trapped in the metal. The bars are scanned with a sensitive SQUID magnetometer to find any trapped monopoles.
- *Timepix Radiation Detectors* are used to monitor the level of highly ionising radiation at the detector. This makes it easier to identify real magnetic monopole signals.

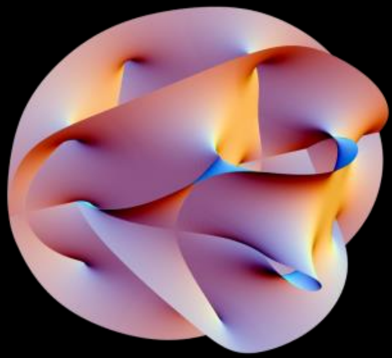
The MoEDAL experiment is an international collaboration consisting of physicists from 21 institutions in 12 countries, including school students from the Langton Star Centre.

Twitter: @MonopoleQuest #MonopoleQuest

Web: http://www.liftapp.ac.uk/MonopoleQuest

What if MoEDAL finds magnetic monopoles?

If discovered, the magnetic monopole will be the first elementary particle that is not part of the Standard Model of particle physics. It would be the first glimpse of new unknown physics.



(Image credit: Lunch)

The discovery of magnetic monopoles would probably have a much greater impact than most other particles physicists are searching for, because they have very special properties:

- Magnetic monopoles are *stable particles*. Once produced, they survive unless they get into contact with an oppositely charged monopole. Therefore they can be trapped and kept for further experiments.
- Magnetic monopoles interact with the electromagnetic field strongly and in a well-understood way. This makes it easy to carry out *new types of experiments* with them.
- The way magnetic monopoles interact with other matter particles depends its the microscopic structure. Therefore experiments with magnetic monopoles would probe the *fundamental laws of nature* at very high energies.
- Because electromagnetism is so important for technology, magnetic monopoles would be likely to have real *practical applications*.

(Image credit: NASA)

What would YOU do with magnetic monopoles? Tell us!

MoEDAL CERN Imperial College London King's College London University of Alberta StarCentre selected The Royal Society Summer Science Exhibition 2015

Twitter: @MonopoleQuest #MonopoleQuest

Web: http://www.liftapp.ac.uk/MonopoleQuest