CREATIONS
Developing an Engaging Science Classroom

UNIVERSITY OF BIRMINGHAM | SCHOOL OF PHYSICS AND ASTRONOMY

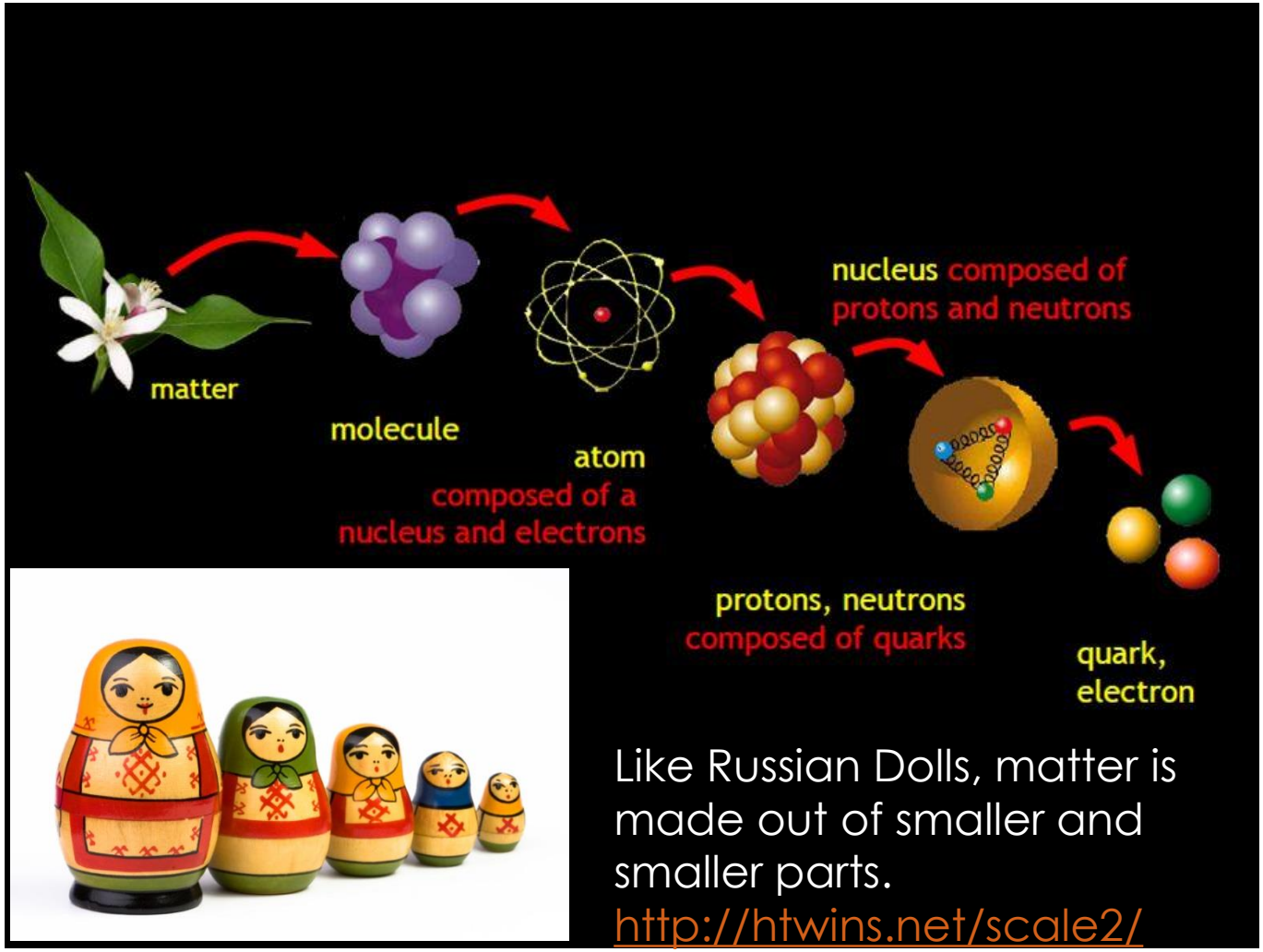
The Ogden Trust
making physics matter

Science & Technology Facilities Council

THE WORLD OF PARTICLES
and their interactions

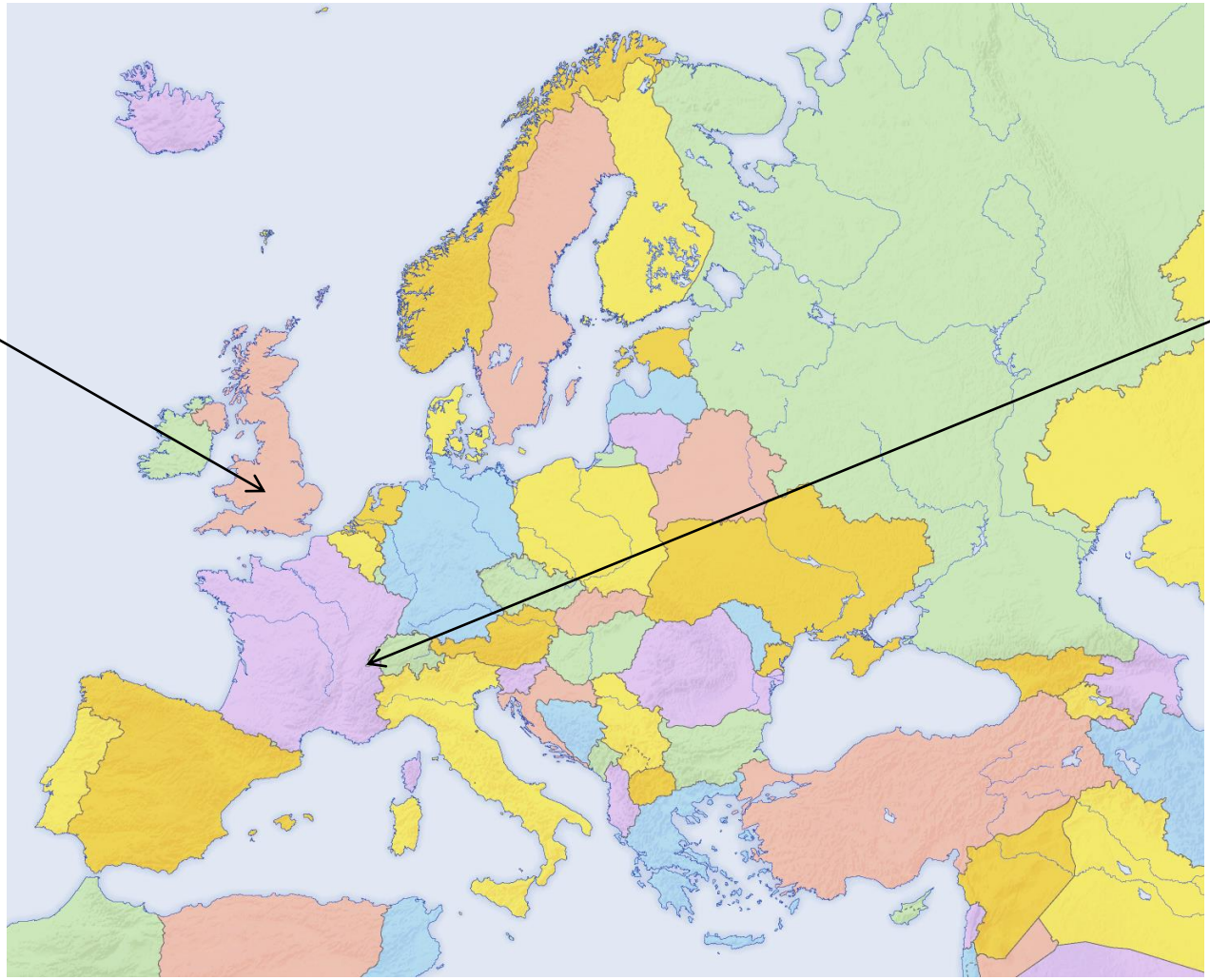
Prof Cristina Lazzeroni
(STFC Public Engagement Fellow) &
Dr Maria Pavlidou
(Ogden Science Officer)

What are the building blocks of materials?



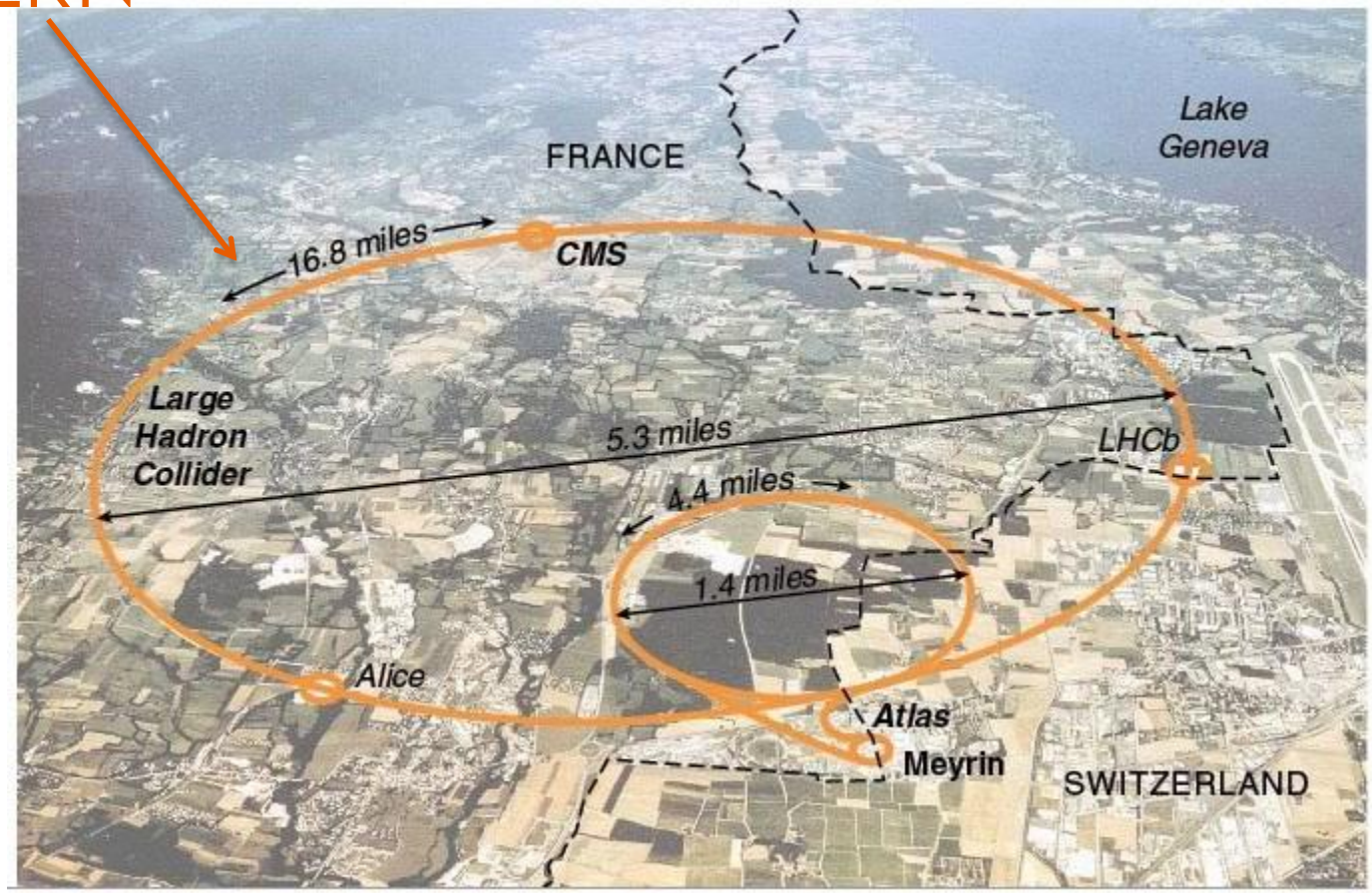
Like Russian Dolls, matter is made out of smaller and smaller parts.
http://htwins.net/scale2/

Where is CERN?



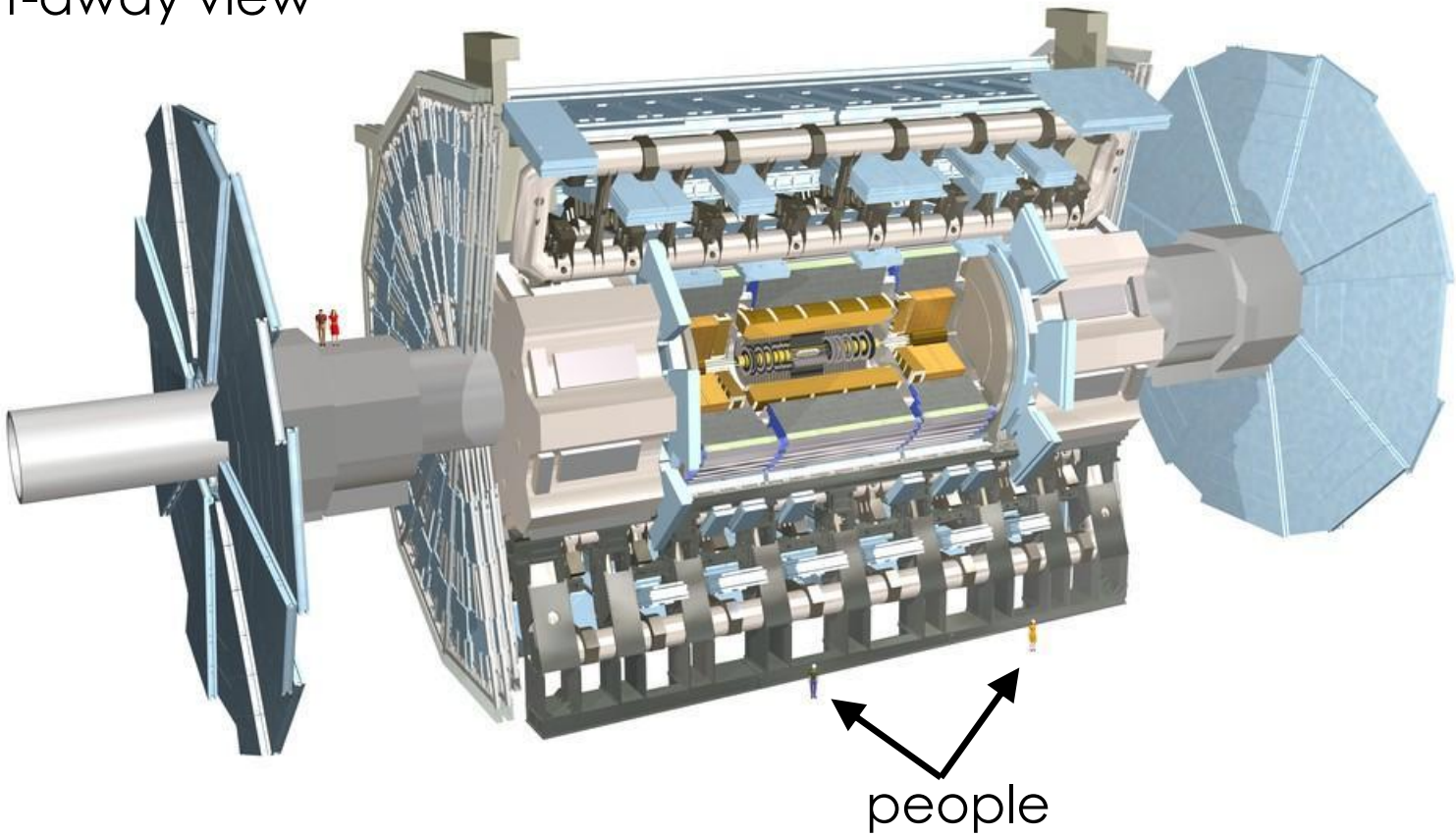
The Large Hadron Collider at CERN

CERN



What is ATLAS?

cut-away view



The particle zoo: the Quark family

 **Name:** Up **Surname:** Quark	 **Name:** Charm **Surname:** Quark	 **Name:** Top **Surname:** Quark
 **Name:** Down **Surname:** Quark	 **Name:** Strange **Surname:** Quark	 **Name:** Beauty **Surname:** Quark

The particle zoo: the Lepton family

 **Name:** Electron **Surname:** Lepton	 **Name:** Muon **Surname:** Lepton	 **Name:** Tau **Surname:** Lepton
 **Name:** Electron Neutrino **Surname:** Lepton	 **Name:** Muon Neutrino **Surname:** Lepton	 **Name:** Tau Neutrino **Surname:** Lepton

The particle zoo: the Boson family

 **Name:** Gluon **Surname:** Boson	 **Name:** Photon **Surname:** Boson	 **Name:** Z **Surname:** Boson
 **Name:** W Plus **Surname:** Boson	 **Name:** W Minus **Surname:** Boson	 **Name:** Higgs **Surname:** Boson

Matter and Anti-matter

Matter: with one white feature e.g. white hat

Anti-matter: with the same feature in black e.g. black hat

Task 1: Happy Families game

Your aim is to collect all six members of any of the families:

- Quarks
- Anti-quarks
- Leptons
- Anti-leptons
- Bosons

The player who collects the most families is the winner.

Rules of the Happy Families game

- The aim of the game is to collect as many families (groups of 6 cards that belong to the same family) as possible.
- Deal out all the cards so that every player gets an almost equal number of cards; this will depend on the number of players.
- The dealer starts by asking another player for a card needed to complete a family.
- If the other player has the card, they must give it to this player.
- The player may continue asking for cards until they make a mistake.
- When a mistake is made the player who was asked for their card takes their turn to request cards.
- During the game, players can request and retake the cards taken from them in previous rounds.
- When a player gathers a family they must put the 6 cards face down on the table in front of them.
- The player who collects the most families is the winner.

Task 2: Make your own particle !

- Read the trump card of your particle
- Design your particle and draw your design on the trump card
- Give mass to your particle by adding plasticine
- Make your particle using the resources

Task 3: Snap game

Your aim is to collect as many cards as you can from the families of quarks, leptons, bosons.

The player who collects the most cards is the winner.

Shout 

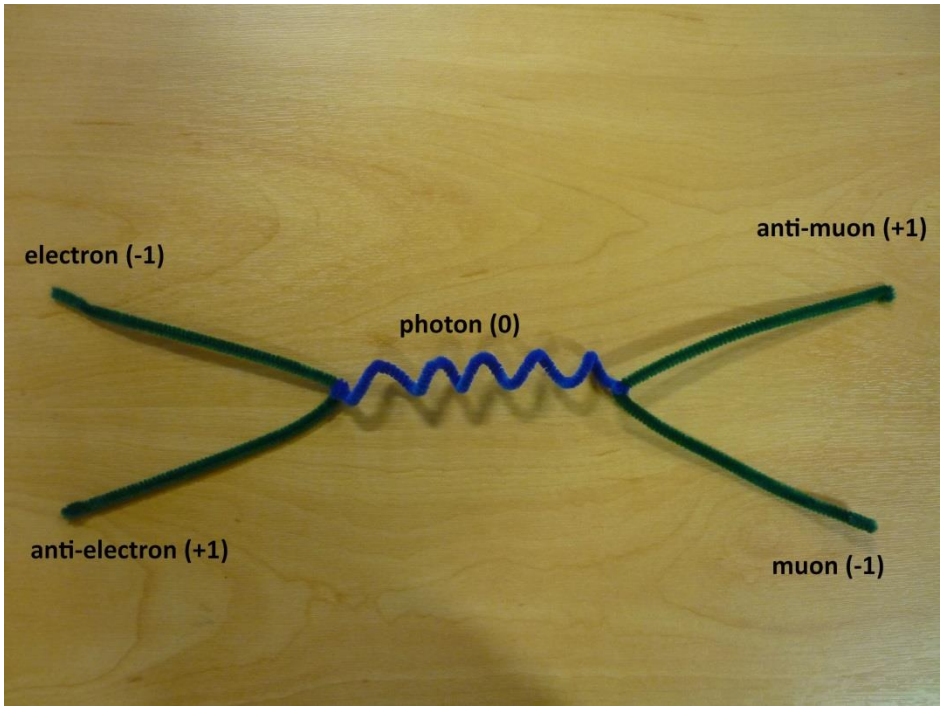
when particles **LIKE** each other!

Rules of the Snap game

- Anyone may deal. The cards are shuffled and dealt out to the players as equally as possible. Players do not look at their cards but keep them in a face down stack in front of them.
- The player to dealer's left begins and the turn to play passes clockwise.
- At your turn you simply turn the top card of your face-down pile and place it face-up alongside. In this way each player forms a pile of face-up cards beside their face-down pile.
- If at any moment two of the face-up piles have particles that **like each other** at the top (for example electron and Z), anyone who notices this shouts "snap!".
- The first person who shouted "snap!" takes both matching face-up piles and adds them face-down to the bottom of their face-down pile.
- The game then continues as before, beginning with the player to the left of the last one who turned a card.
- If you have no face-down cards left when it comes to your turn, you simply turn over your face-up pile to make a new face-down pile and turn over the top card as before.
- If you have no cards left at all, you are out of the game. The last player in is the winner (or alternatively, the player with the largest number of cards).

Task 4: Write your own particle story

- Particles meet with each other
- Particles can turn into other particles and then to new particles
- Particle meetings follow the rules of likes and dislikes



Build your own story using pipe cleaners and following one of the examples given.

Example of a story

One sunny day Jimmy the **electron** and Molly the **anti-electron** were playing in their garden eating cookies and drinking orange juice. Jimmy started feeling really hot from the sun. Molly said "oh poor you…". She took his hand to comfort him but suddenly…they both disappeared!

In their place a very greedy **photon** appeared who started eating all the cookies. The cookies were many and the photon got bigger and bigger until… it exploded with a big "splat" sound!

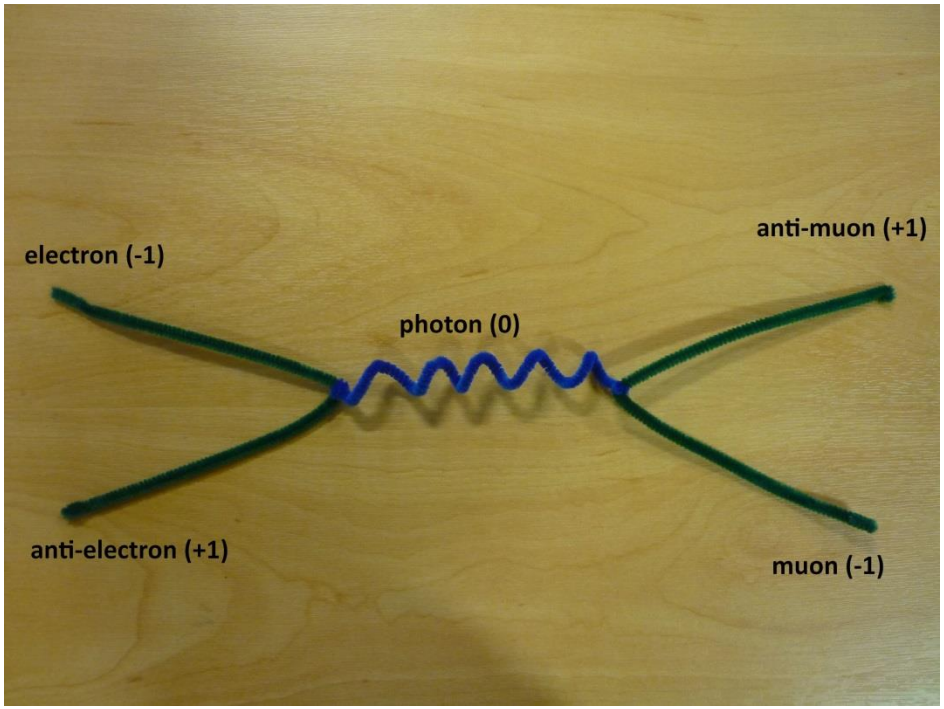
Left behind were two chatty **muons** who immediately started to discuss the wonders of this world and how too many cookies in one go are bad for you…

Feynman Diagrams:

Additional Material
For High School Students

Particles write stories: Feynman diagrams show these stories

- Particles interact with each other
- Particles can turn into other particles and then to new particles
- All particles have charge (positive, negative or zero)
- During their interactions, the total charge stays the same
- Interactions follow the rules of likes and dislikes



References

- Slide 2: building blocks of matter from http://rooksheathscience.com/2014/06/, Russian dolls from http://www.kzero.co.uk/
- Slide 3: Europe map from http://commons.wikimedia.org/wiki/Atlas_of_Europe
- Slide 4: map of LHC from http://imgarcade.com/1/lhc-map/
- Slide 5: ATLAS from http://atlas.ch/
- Slides 6, 7,8, 9: the particle zoo from http://www.particlezoo.net/
- Slide 13 snap image from http://www.milwaukeemarketingresults.com/Snap-/13194572?pid=283521
- Slide 16: cartoon 1 from http://www.picturesof.net/ cartoon 2 from https://chefpeterpang.wordpress.com/ and cartoon 3 from https://www.colourbox.com