

Episode 532: Preparation for the particle physics topic

It is important to avoid turning this entire topic into 'stamp collecting'. The underlying themes to develop here are that discoveries in nuclear physics, accelerating during the middle of the twentieth century, resulted in a need to classify the particles discovered. The key to this classification was the application of conservation laws, some of quantities already well established (charge, baryon number), some modified from earlier versions (mass/energy) and some new (lepton number) or even bizarre (strangeness is the one met here, but there are also parity, isospin and hypercharge). The other aspects developed are: antiparticles, the explanation of particle interactions in terms of exchange particles (vector bosons), and the development of the standard model of three generations of quarks and leptons to explain and simplify the 'particle zoo.'

Episode 533: The particle zoo

Episode 534: Antiparticles and the lepton family

Episode 535: Particle reactions

Episode 536: Vector bosons and Feynman diagrams

Advance warning

The first topic makes use of activities based on card sorting and arranging. The baryon, meson and lepton cards suggested here have been constructed for this project, but other excellent examples have been published, and it is well worth your considering the following:

A resource for particle physics teaching in schools, Ken Zetie, *Physics Education*, March 2003, 38, p 107 with sets of online resources

Playing with Particles – a teaching approach for A-level (post-16) particle physics, David Brown, *School Science Review*, December 2002, 84 (307), pp 118-123

For more wide-ranging resources on the teaching of particle physics at this level, see the TRUMP Particle Physics project from York University (www.york.ac.uk/org/seg/trump/parthome.htm).

Main aims

Students will:

Use the terms baryon, meson, hadron and lepton.

Know that, for each particle, there exists an antiparticle.

Apply conservation rules to particle interactions, including particle annihilation and creation.

Know that interactions between fundamental particles (quarks and leptons) are due to the exchange of other particles (vector bosons), and that these are (virtual) photons for the electromagnetic interaction and W^+ , W^- and Z^0 particles for the weak interaction.

Construct and interpret Feynman diagrams showing interactions.

Prior knowledge

Students should know about the constituent particles of the atom (protons, neutrons, electrons). They should be familiar with the ideas of conservation of mass, energy and electric charge.

Where this leads

The first topic deals with the fundamental particles that students have already met, and how their number proliferated in the second half of the twentieth century. Classification of the different sorts of fundamental particles then leads to use of conserved quantities (some rather bizarre) to establish rules for particle reactions.

Students will learn that particles can be classified as hadrons – baryons and mesons – and leptons, each with its anti-particle, and they should know that interactions between these particles can be described in terms of transfer of other particles known as vector bosons.

Once the ground rules for particle interactions have been established, students can go on to learn that there is a finer level of structure to mesons and baryons.