CERN PHYSICS

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Summary

CERN (the European Laboratory for Particle Physics) exists to provide accelerators and particle beams for physicists, primarily in the member states and increasingly to non-member states.

In order to understand *what* CERN should do it is necessary to know *why* CERN exists, and this means understanding the aims of particle physics.
These are simply stated:

1. Identify the fundamental constituents of matter
2. Identify the forces through which they interact.

The last 50 years, and especially the last 20 years, have seen enormous progress, and CERN has played a very important part in the development of the 'Standard Model' of particle physics.

Briefly, there are two types of 'matter particles' - quarks (two of which - the *up quark* and the *down quark* - make up the proton and neutron, among other things) and leptons (the *electron* and its *neutrino* being the ordinary examples). There are three 'forces carrying particles' -- the photon which carries the electromagnetic force, the gluon which carries the strong (nuclear) force and the W and Z particles (discovered at CERN) which carry the weak force.

However, the standard model is incomplete in several ways. Firstly, in its purest form, all of the particles in it are strictly massless whereas in the real world things are demonstrably massive. Secondly, there are a large number of parameters that just have to be measured, and there is a belief that a true theory should predict what these parameters (mainly the actual masses of the particles) should be. We need to know why nature has provided us with more than the bare minimum of particles (the up and down quarks and the electron and its neutrino) needed to create the universe we see today. Finally, the most familiar force - gravity - is still not included in the description of the forces.

The future programme of particle physics, and therefore the future programme of CERN, is dedicated to finding answers to these questions. This can be either by addressing some specific question directly (for example, to see whether the mechanism proposed by Peter Higgs in 1967 for giving the particles mass is correct); by providing more information about the particles (eg. whether the neutrinos have mass); or by finding new types of particle, for example, supersymmetric particles.

The CERN programme - through the LHC and other experiments - is designed to provide answers to some of these questions, and to lead particle physics from the 'standard model' to the 'standard theory of everything'.