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Is nature symmetrical?

Since the turn of the last century, physicists have discovered a treasure trove of particles. Some are composite, others fundamental. One particularly interesting set of particles are the antiparticles that annihilate when meeting with their particle counterparts, much like the doppelgänger. For example, the positron which is the antiparticle of the electron has exactly the same mass as the electron but with opposite charge and spin. If an electron looks at mirror, its image on the mirror will be the positron. Hence the question, is nature symmetrical?

The Standard Model (SM) of particle physics is currently the best model we have that incorporates three fundamental forces: electromagnetism, weak and strong. It explains the nuclear force, light and radioactivity. It does however have its limitations. The coupling strengths of the fundamental forces do not converge at grand unification energies (GUT) at 10^{16} GeV. Another is that the radiative corrections of a Higgs with low mass could blow up at GUT. Both are not required to be true for physics to work at those energies but it would be an elegant, beautiful and symmetrical solution if it were. Similar to how the positron, the antiparticle of the electron solved a similar problem caused by the electron self-potential, physicists today are studying the possibility of an elegant theory of supersymmetry that might be able to answer the questions posed by the SM today.

Supersymmetry (SUSY) is a simple extension of the Standard Model that reuses the interactions between particles but doubles their number. Each fermion and boson in the SM gets a heavier bosonic and fermionic partner. In this way, it allows for the the three fundamental forces described earlier to unify at the GUT energy. In addition, there will be no problems with the Higgs boson mass. The only tricky thing is that we have not seen enough data to determine the existence of these supersymmetric particles.

Today, physicists at the largest particle accelerator at CERN, Geneva are working hard to look for the final piece of the SM puzzle, the Higgs boson. Many are also looking for hints to supersymmetry, hidden extra dimensions and other exotic particles. We do this using general purpose particle detectors like ATLAS and CMS record data from particles generated by colliding protons circling the accelerator at a combined collision energy of 7 TeV. These then create fragments, or fundamental particles which may include the Higgs boson and SUSY particles. In the past year alone, they have recorded petabytes of data verifying the SM and increasing our knowledge of the W, Z bosons and the top quark. There is hope that we may see the Higgs boson or supersymmetry at the end of the year.

One of the main problems with detecting SUSY particles is that it only interacts gravitationally and weakly. Like the neutrino, it may pass through lots of matter over huge distances before colliding with another SM particle. Consequently, physicists have developed some SUSY theories that explains the lightest stable particle (LSP) to be dark matter. The LHC may be able to create this particles. Finding these particles may be the most exciting development in physics since quantum theory.

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