The Search for the Top Quark

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Quarks and the Standard Model

Quarks are fundamental particles. They come in different sizes, charges and flavours. Two known quarks, arranged in different ways, comprise the protons and neutrons found in atoms. The Standard Model, a model that describes the interaction and relationships of all known particles, predicts the existence of the sixth quark, the top quark.

Experimentally, top quarks are produced from the collisions of protons and antiprotons in particle accelerators.

The top quark is very unstable and thus decays extremely fast. Therefore, physicists can never actually see the top quark. They must sort through the immense data left from the collision of the proton and antiproton, looking for “top signatures”, i.e. decay modes of the top quark. The next step is a reconstruction of all the information associated with the decay to “see” the top quark.

Reconstruction Techniques

The data collected by the CDF detector is reconstructed using specially designed algorithms to produce "images" of the collisions, as shown here. The circular diagram shows the collision as viewed along the proton direction. The 2-dimensional plot shows the direction and energy of the particles resulting from the top quark decay.

There were 7 events that could be completely reconstructed. The top quark mass frequency distribution for those event, shown here, has a peak that is a indication that most of these events really came from top quark decays.

Conclusions

The discovery of the top quark was not obvious. It was the result of a long and hard process of collecting and analyzing data. Its discovery is due to many collaborators who devoted years to its pursuit.

As technology advances, particle accelerators will be able to produce more collisions and thus more top quarks. This information will allow physicists to study these mysterious particles more in depth.