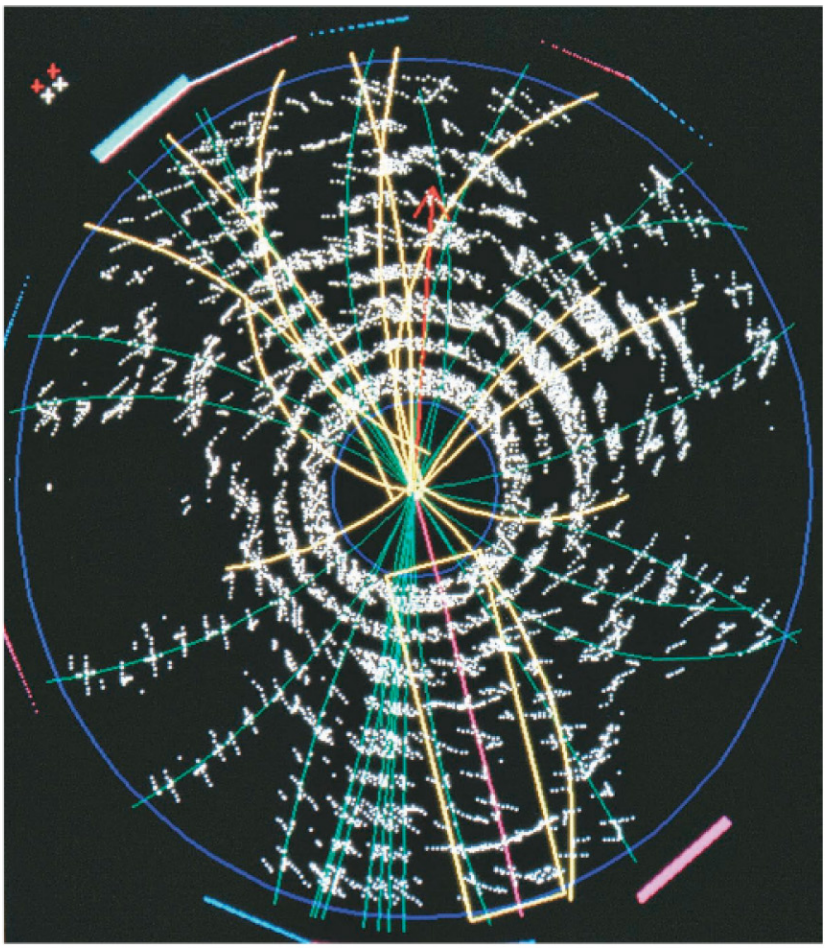
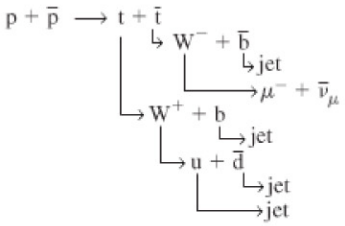


This computer-generated reconstruction of a proton–antiproton collision at Fermilab (Fig. 32–3) occurred at a combined energy of nearly 2 TeV. It is one of the events that provided evidence for the top quark (1995). The wire drift chamber (Section 30–13) is in a magnetic field, and the radius of curvature of the charged particle tracks is a measure of each particle's momentum (Chapter 20).

The white dots are the electric wires of the drift chamber (Fig. 30–16). The colored lines are the particle paths.

The top quark (t) has too brief a lifetime ($\approx 10^{-23}$ s) to be detected itself, so we look for its possible decay products. Analysis indicates the following interaction and subsequent decays:



The tracks in the photo include jets (groups of particles moving in roughly the same direction), and a muon (μ^-) whose track is the pink one enclosed by a yellow rectangle to make it stand out. After reading this Chapter, try to name each symbol above and comment on whether all conservation laws hold.

CHAPTER 32

Elementary Particles

In the final two Chapters of this book we discuss two of the most exciting areas of contemporary physics: elementary particles in this Chapter, and cosmology and astrophysics in Chapter 33. These are subjects at the forefront of knowledge—elementary particles treats the smallest objects in the universe; cosmology treats the largest (and oldest) aspects of the universe. The reader who wants an understanding of the great beauties of present-day science—and/or wants to be a good citizen—will want to read these Chapters, even if there is not time to cover them in a physics course.

In this penultimate Chapter we discuss *elementary particle* physics, which represents the human endeavor to understand the basic building blocks of all matter. By the mid-1930s, it was recognized that all atoms can be considered to be made up of neutrons, protons, and electrons. The basic constituents of the universe were no longer considered to be atoms but rather the proton, neutron, and electron. Besides these three "elementary particles," several others were also known: the positron (a positive electron), the neutrino, and the γ particle (or photon), for a total of six elementary particles.