of new kinds of matter. The astrophysical case for dark matter in the galaxy is persuasive, and the evidence that most of the matter in the Universe is both nonluminous and unlike the stuff we know is highly suggestive. Supersymmetry, which is for the moment the most popular candidate to extend the electroweak theory, implies a greatly expanded list of elementary particles, including spin-zero partners of the quarks and leptons.

If we take as our goal not merely describing the world as we find it, but understanding why the Universe is the way it is, the array of elementary particles presents us with many challenges. What makes a top quark a top quark, or an electron an electron? Can we calculate the masses of the quarks and leptons and the relative strengths of the weak transitions between quark flavors? Why are there three generations?

ANOTHER LAYER OF STRUCTURE?

No experimental evidence except the history of molecules and atoms and protons suggests that quarks and leptons are composite. However, there is an undeniable aesthetic allure to the notion that a complex world may arise out of the combinatoria of a few simple parts. If today's elementary particles are composite, we might be able to compute their masses, understand the trebling of generations, and decipher the relationship of quarks to leptons.

Some specific currents in theoretical research also lead toward composite quarks and leptons. In dynamical theories of electroweak symmetry breaking such as technicolor, the longitudinal components of the weak gauge bosons are composite. Why not the quarks and leptons, too? And a new approach to supersymmetric model-building, in which strong gauge interactions break the supersymmetry, suggests that some of the quarks may be composite.

The idea that elementary constituents of matter interact according to the dictates of gauge symmetries has become the organizing principle of particle physics, as important to our field as evolution is to biology.

Composite models of quarks and leptons must differ in a crucial way from familiar dynamical pictures. In QCD the pions are the lightest—nearly massless—particles, while the proton mass is set by the scale of binding energy. A theory of quark and lepton compositeness must deliver fermions much lighter than the (several TeV, at least) binding energy of the constituents. Without a specific composite model, we have no theoretical clue for the scale on which we might resolve structure in our elementary particles. Nevertheless, we can characterize the experimental signatures that composite quarks and leptons would leave.

At energies approaching such a compositeness scale, quarks and leptons that have size will interact at such short distances that they interpenetrate and rearrange, or even exchange, their constituents. In quark-quark scattering, the conventional gluon exchange of QCD would be supplemented by a contact interaction whose strength is determined by the size of the quarks. In $\bar{p}p$ collisions, this new contribution would lead to an excess of hadron jets at large values of the transverse energy, where quark-antiquark scattering is the dominant reaction. Typically, the angular distribution of the jets will differ from the shape QCD predicts. If quarks and leptons have common constituents, a similar excess will be seen in dilepton production from the elementary process $\bar{q}q \rightarrow \ell^+\ell^-$. At still higher energies, we would expect to see the effects of excited quarks and leptons. Finally, at energies well above this compositeness scale, quarks and leptons would begin to manifest form factors characteristic of their size.

Since I first met the quark, charm, beauty, top, and the rest have become my friends and teachers—in fact, they have taken over my life. The idea that elementary constituents of matter interact according to the dictates of gauge symmetries has become the organizing principle of particle physics, as important to our field as evolution is to biology. I don't know how far the revolution of quarks and leptons and gauge bosons will carry us, but I have a wish for the decade ahead: that we will learn the true nature of electroweak symmetry breaking and begin to understand the individuality of the quarks and leptons. And I hope we will look back with pleasure and satisfaction at how passionate and optimistic—and naïve—we were in 1997.