Experiments in Particle Physics Explore Fundamental Issues

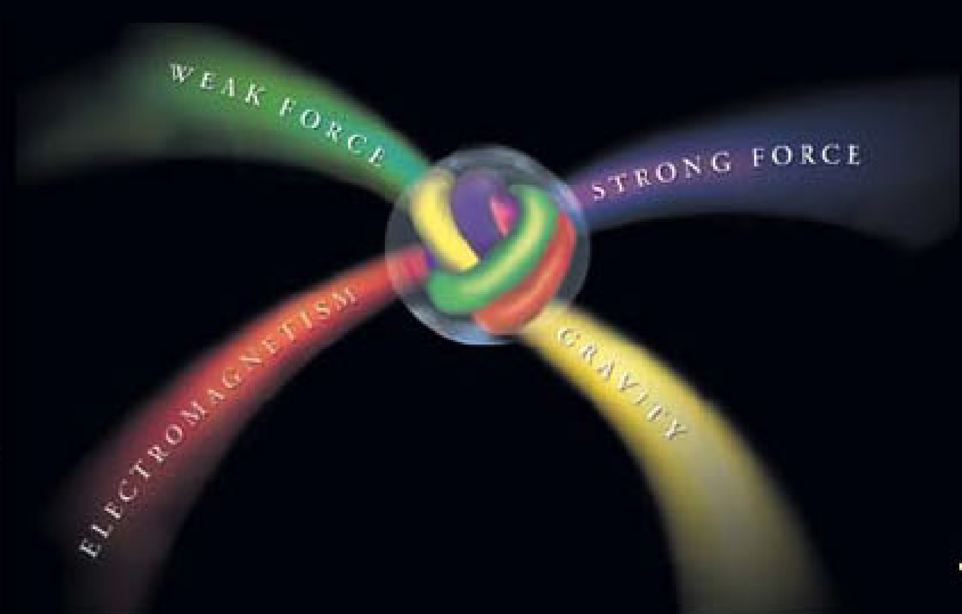
$E=mc^2$

The Origin of Mass

Energy is part of our universe, but why does mass exist? Experiments are currently searching for a particle called a "Higgs boson" that is believed to generate mass. Modern ideas such as supersymmetry and string theory may provide a deeper understanding.

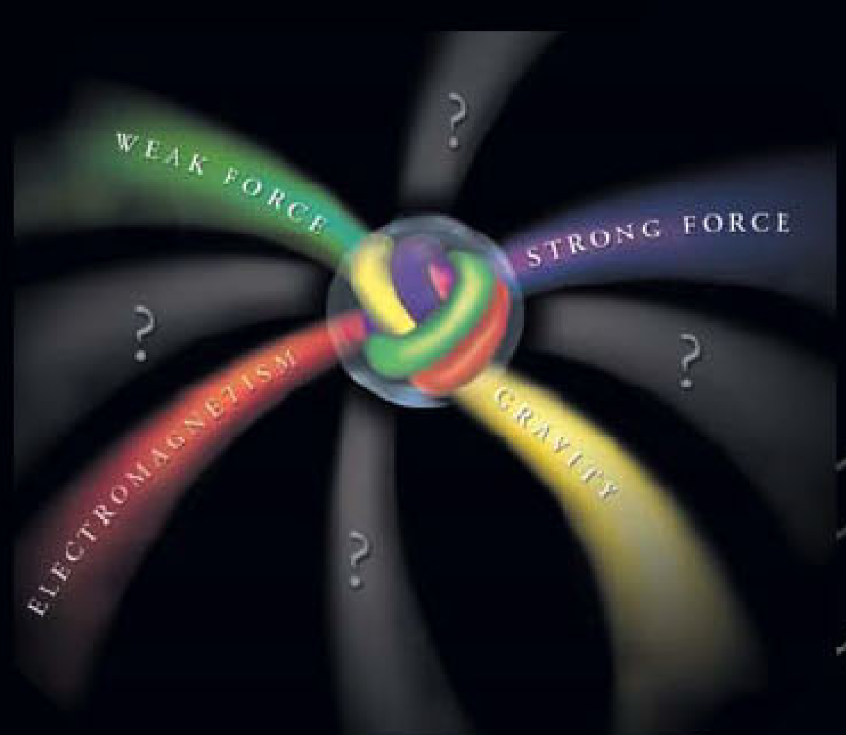
Unification of the Fundamental Forces

Since Einstein's time, we have sought a theory that unifies the forces of Nature. At last we may be close to a theory joining gravity to the strong force that binds the nucleus, the electromagnetic force that holds atoms together, and the weak force that produces the kind of radioactivity used in dating old artifacts with Carbon-14.



New Forces of Nature

Four fundamental forces are known, but there are reasons to think there may be more forces in nature, including the "anti-gravity" force that seems to be accelerating the expansion of the universe.



The Path of Discovery

Human curiosity fuels our desire to understand the natural world at ever deeper levels and has led to our greatest achievements in science and technology.

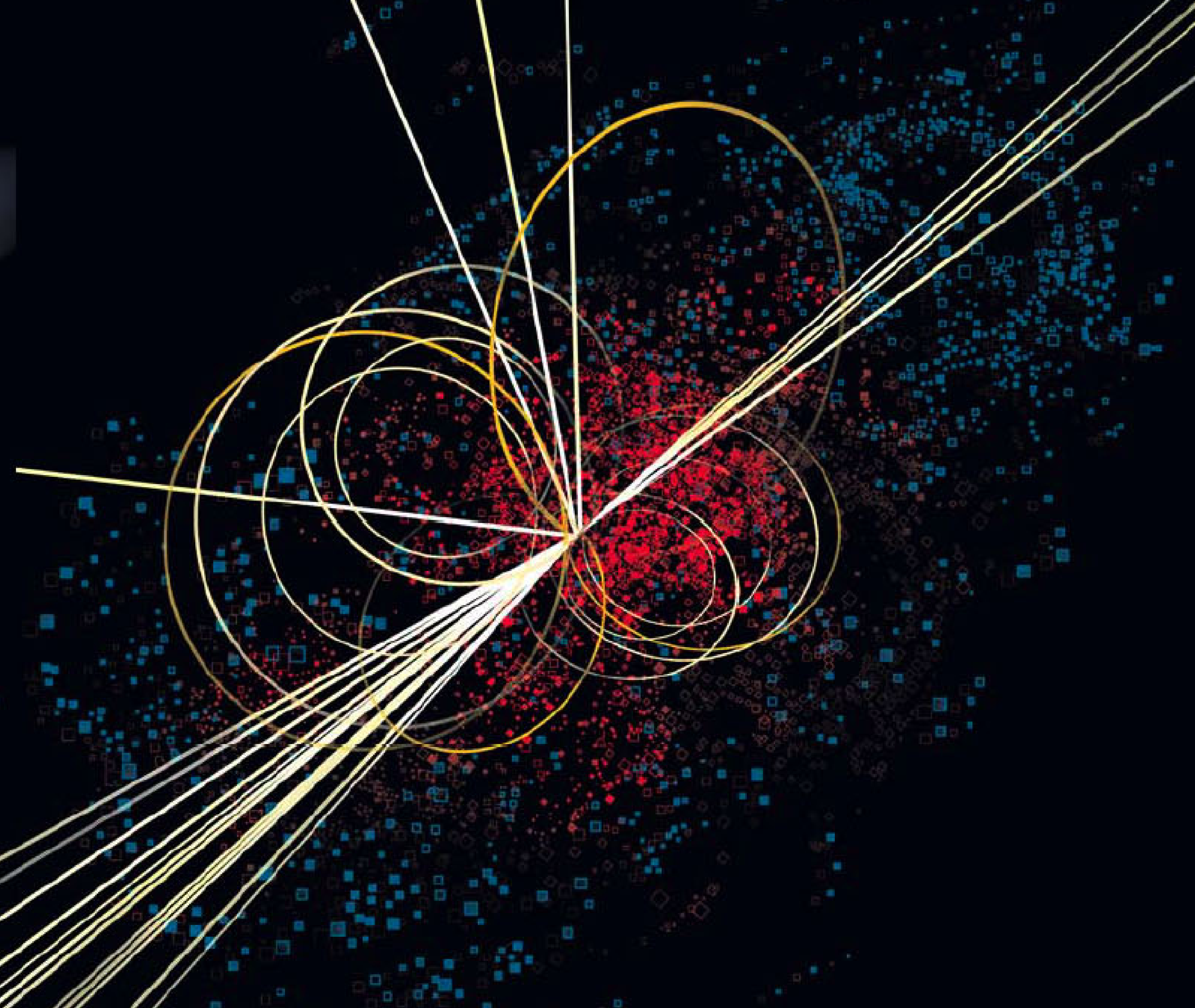
Driven by new puzzles in our understanding of the physical world, particle physicists are following paths to new wonders and startling discoveries. Steps along the path include experiments using everything from supersensitive devices on a laboratory tabletop to giant particle accelerators.

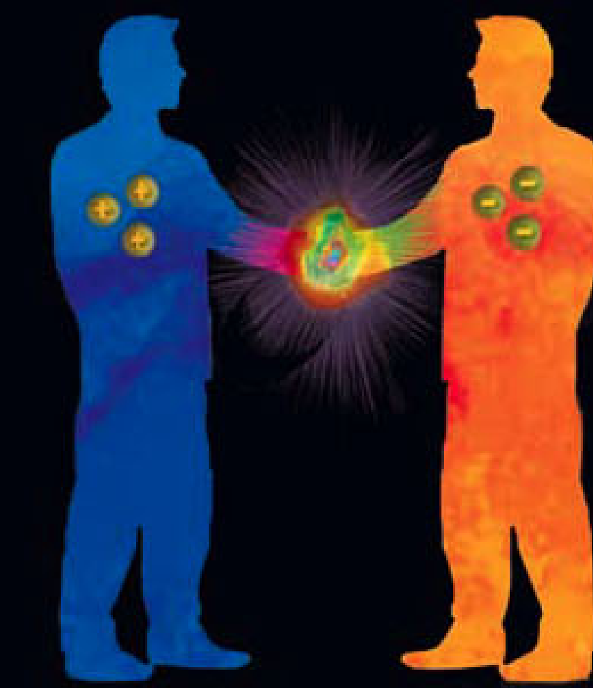
The interactions of fundamental particles such as electrons, quarks, and neutrinos, determine the ultimate fate of the universe and the structure of space itself.

Hidden Dimensions of Space

We're all familiar with the three-dimensions of space, but strange as it may seem, there may be additional dimensions we just cannot see. Evidence for hidden dimensions may soon appear in experiments, perhaps in particle collisions like the one below. Hypothesizing extra dimensions helps us understand an otherwise puzzling collection of facts about nature.

Although this is only one of the fascinating questions facing particle physics in the new millennium, we use it on the inside pages to illustrate how particle physics is done and what it may be able to show us.



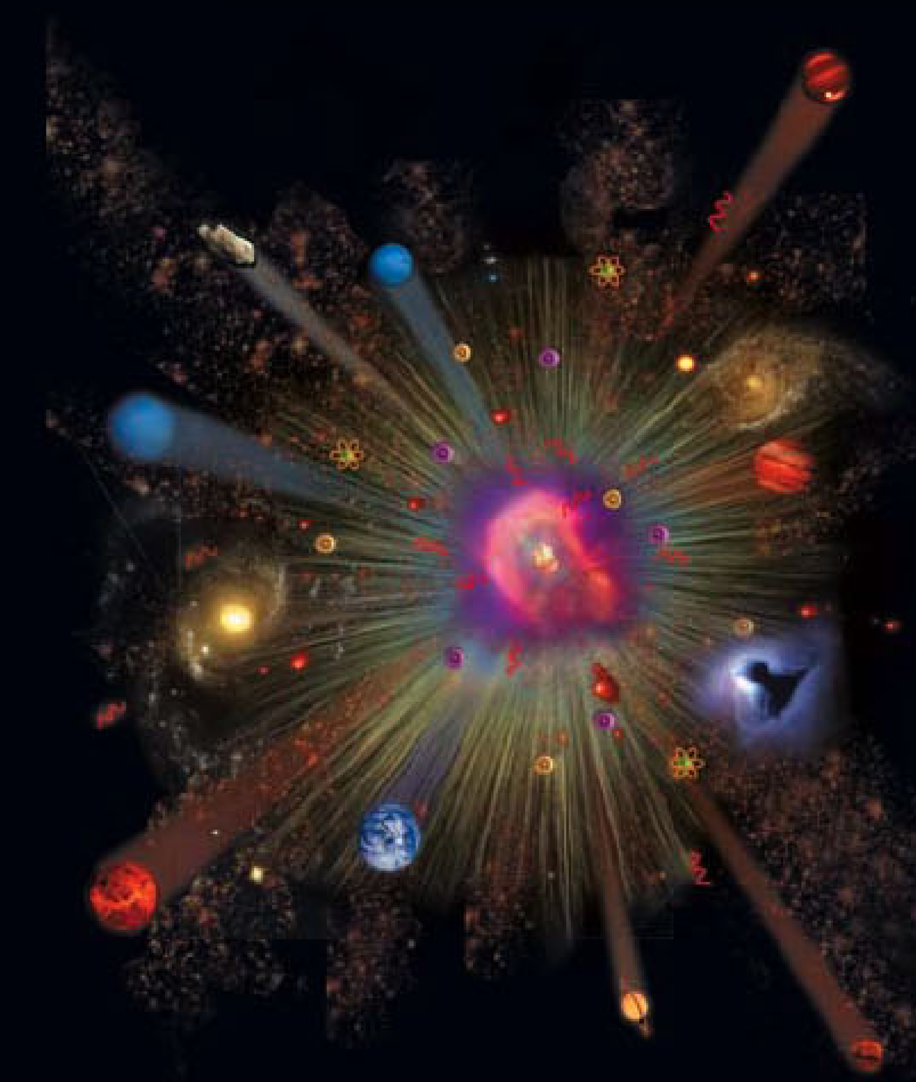


The Missing Antimatter

Matter and antimatter were created in the Big Bang. Why do we now see only matter except for the tiny amounts of antimatter we make in the lab and observe in cosmic rays? When matter and antimatter meet, they annihilate into pure energy.

The Birth and Fate of the Universe

As the universe expanded after the Big Bang, particles such as quarks and photons emerged. Eventually it was cool enough for atoms to form. Gravity pulled matter together to make stars and galaxies. Gravity slowed the expansion of the whole universe. Yet today there is evidence that the universe's expansion has speeded up. What could account for this?



The Nature of Dark Matter and Dark Energy

Astrophysical observations of galaxies and of distant supernovae seem to indicate that much of our universe is dominated by forms of matter and energy unlike anything we have previously seen. Ultra-sensitive experiments attempting to directly detect this dark matter in the laboratory are presently underway.