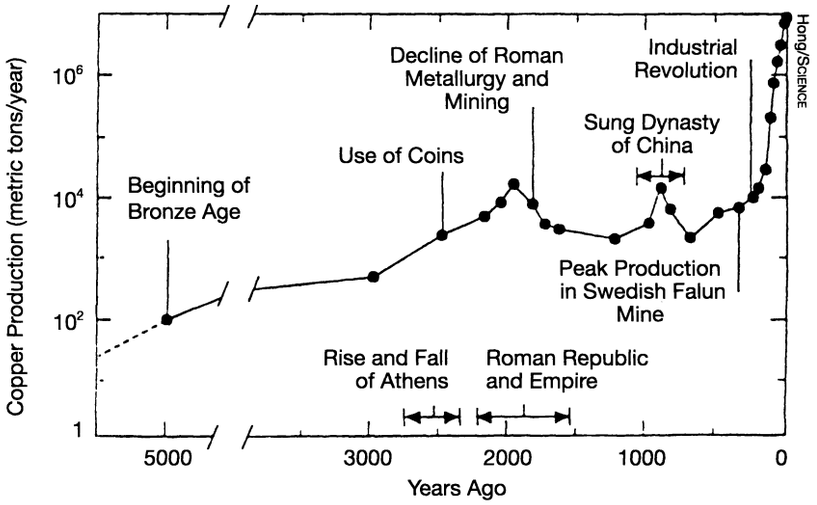
officials banned mining near some cities in Italy, perhaps because of the noxious vapors from smelting, which some Roman writers mentioned, says Nriagu. As a result of inefficient techniques, early metallurgy emitted by-products in much higher concentrations than did practices adopted in the 19th century.

Analysis of glacial ice can provide unique insight into how much metal the ancient world used, says Boutron. "Archaeologists have a lot of problems being quantitative for this early period. Here is a new, promising way to get quantitative data for archaeologists."

— R. Monastersky



Fluctuations in copper production, estimated from archaeological sources.

Hint of supersymmetry in proton collision

When a proton meets an antiproton head-on in a high-energy collision, the crash can generate a variety of particles. Of the millions of such interactions observed at the Fermi National Accelerator Laboratory's Tevatron collider near Batavia, Ill., one event stands out because it doesn't fit the standard theory describing the fundamental particles and forces of nature.

This intriguing collision produced two electrons, two gamma-ray photons, and little else that could be detected. The four scattered particles carried away a large amount of energy at right angles to the proton beams, yet scientists have been unable to account for much of the energy that went into the collision.

To some theorists, this observation constitutes the first tantalizing hint in collider data that a so-called supersymmetry theory may provide a more complete, unified picture of nature than the widely accepted, but incomplete, standard model of particle physics.

"You don't usually get events like this," says Gordon L. Kane of the University of Michigan in Ann Arbor. "To me, it's very exciting because it's what I would expect from supersymmetry."

"It's just one event, and it may never happen again, but it fits very well with a supersymmetric explanation," says Michael Dine of the University of California, Santa Cruz.

Dine and his coworkers and Kane and his group offer alternative supersymmetrical explanations of this event in two reports accepted for publication in Physical Review Letters.

According to the standard model of particle physics, there are two kinds of fundamental particles in nature: force-carrying particles called bosons, which include photons, and matter particles called fermions, which include quarks and electrons (SN: 7/1/95, p. 10). These particles all have antimatter counterparts.

Supersymmetry theory represents an extension of the standard model that brings these two types of particles and antiparticles into one framework. It posits that all known fermions have boson partners and that all bosons have fermion partners. For example, scientists call the electron's hypothetical partner a selectron and the photon's partner a photino. The partners are thought to be so heavy that they would be created only infrequently, if at all, at the energies provided by today's colliders.

Researchers have been studying various types of supersymmetry theories for more than a decade, working out what sorts of events might serve as evidence for the existence of these heavy partners.

For the one distinctive event observed at the Collider Detector at Fermilab (CDF), Kane and his coworkers offer a scenario in which the collision directly created two selectrons, each with a mass between 80 and 130 gigaelectronvolts. These exotic particles, in turn, would have transformed themselves, via a series of intermediate products, including a photino, into the electrons and photons actually detected and perhaps some other particles.

Dine and his colleagues have been investigating an alternative formulation of supersymmetry theory. In this scenario, particles other than selectrons would have appeared in the CDF event.

If either of these assessments is correct, there might be analogous events not yet recognized in the CDF data now available. Experiments scheduled at the upgraded Large Electron-Positron (LEP) collider at the European Laboratory for Particle Physics near Geneva may provide additional evidence.

"If this is right, there's a good chance that some more [supersymmetrical events] will show up this summer at LEP when they start taking data again," Kane says. "That will be exciting to watch."

— I. Peterson

Stress undercuts flu shots

The strain of looking after a loved one with a protracted, debilitating illness can impair an elderly caregiver's immunity, a new study indicates.

John Sheridan of the Ohio State University College of Dentistry in Columbus administered flu shots to 64 elderly men and women. Half had been caring for a spouse with Alzheimer's disease or some other form of progressive dementia for about 7 years.

"When you vaccinate somebody, you generally want to see a fourfold increase in the antibodies they have," Sheridan notes. But only about 37 percent of the caregivers mounted such a defense against flu viruses—roughly half the rate seen in the other participants. Several other measures of cellular and antibody-based immunity appeared to be similarly compromised, he and his colleagues report in the April 2 Proceedings of the National Academy of Sciences.

This is the first study to demonstrate significant stress-induced reductions in the apparent efficacy of an important vaccine among the elderly, he says.

"If you're a caregiver and chronically stressed, make sure you get the vaccine every year," he recommends, because marginal responses to the vaccine often improve in succeeding years.

Outside pursuits and friends also help, adds psychologist Janice K. Kiecolt-Glaser of the Ohio State University College of Medicine in Columbus, who led the study. "We know from earlier work in our lab that caregivers who appear to fare best psychologically and immunologically are those who report greater social support and more satisfying social relationships."

— J. Raloff