some animals. Psychologists have found that infants aged less than a year display basic numeracy. For example, in work discussed at the meeting, Arizona University psychologist Karen Wynn studied the response of infants aged 8 to 10 months when two similar dolls are placed behind a screen and one of the two dolls is sometimes missing when the screen is lifted. Wynn found that infants will look at the single doll for much longer, apparently puzzled by the disappearance of the second doll. This suggests infants can do simple arithmetic and memorize objects before language competence develops.

LEONARD LEE RUE III/ANIMALS, ANIMALS

Go figure. New research suggests that rhesus monkeys can do simple arithmetic.

Hauser and his colleagues tested a colony of semi-free-ranging rhesus monkeys for the same skills with pairs of bright purple eggplants. They found that, like infants, these Old World monkeys looked longer at the impossible outcome—when two fruits were placed behind the screen but only one was present when the screen was removed. "From these results, adult rhesus monkeys and 8- to 10-month-old human infants appear to have comparable abilities for simple arithmetical computations," says Hauser, implying that this skill is hardwired in the brain.

The evolutionary programming may have taken place long ago, because Hauser observed similar responses in New World monkeys—a captive colony of cottontop tamarins. If the observed behavior is a common adaptation, it dates back to before the divergence of these primate groups, and hence long predates the emergence of humans. "Comparative studies using similar methods are vital to help study which cognitive abilities are evolutionary adaptations," says Hauser.

Oxford's Kacelnik is finding an even deeper evolutionary root for the human tendency to "discount" future events—trading off the value of opportunities in the future for rewards now. He and his colleagues carried out a study of discounting in captive starlings, using a test system varying the size and delay of food rewards. They found a distinctive pattern of behavior in which the perceived value of future rewards diminished rapidly with time, on a hyperbolic curve that gave high value to short-term gains and maximized the rate of reward rather than its overall value.

Kacelnik compared these results with a number of studies of human discounting and found the pattern of response was remarkably similar to that in the birds, suggesting that the tendency to maximize short-term rewards may have an evolutionary root and that "play today" has been a successful strategy in the past. Although similarity alone does not prove an evolutionary link—the same kind of behavior could have evolved independently in humans and starlings—Kacelnik believes such results will lead to further tests of animal and human behavior. "A key challenge for adaptationist thinking is to produce precise predictions about psychological mechanisms," he says.

But already, advocates of a Darwinian approach to psychology are emboldened by their successes. They are carrying the search for built-in psychological adaptations to questions ranging from the psychological differences between males and females and conflicts of interest between parents and offspring to morality and political behavior. Says psychologist John Tooby of the University of California, Santa Barbara, "People come factory-equipped. There's stuff built into brains."

–Nigel Williams

PHYSICS

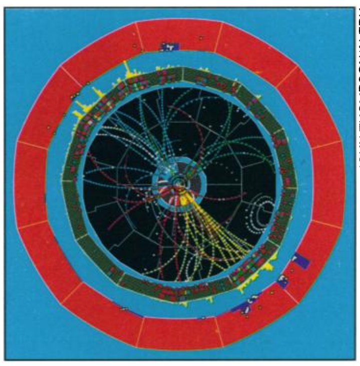
Improbable Particles—or Artifacts?

"When you have eliminated the impossible, whatever remains, however improbable, must be the truth," wrote Sir Arthur Conan Doyle. Eliminating the impossible is just what researchers at CERN, the European Center for Particle Physics, are now trying to do. *Science* has learned that over the past year, one of the four huge detectors on the Large Electron-Positron Collider (LEP) has picked up 18 unusual events that don't fit into any known physics, yet are so tantalizing that, so far, physicists can't write them off.

In each case, the ALEPH detector recorded four jets of mesons and similar particles spraying from high-energy collisions of electrons and antimatter positrons. The total mass of the daughter particles always added up to 106 billion electron volts (GeV), but the two pairs of jets made unequal contributions. This pattern could imply that a short-lived pair of dissimilar particles lived briefly after each collision before decaying to produce the jets. But existing physics has no candidates. "This large peak that ALEPH is seeing is completely unexpected from the Standard Model point of view," says CERN theorist Carlos Wagner. Nor do the events fit neatly into popular extensions of the existing theory, such as a scheme called supersymmetry.

Odder still, the other three detectors on LEP have seen nothing comparable. "It's somewhat bizarre that, if there is anything there, they are seeing nothing," says ALEPH's spokesperson-elect Peter Dornan, an experimentalist based at Imperial College London. Now, with the help of colleagues from other detector groups, the ALEPH researchers are trying to determine which is more improbable: that they have made a mistake, or that the so-far-inexplicable events are real.

ALEPH researchers noticed the first events in data taken in 1995, when LEP was colliding electrons and positrons at energies of about 130 GeV. Following a standard analytic procedure, the researchers scanned the debris of the collisions for distinct particle jets—the signatures of decaying massive particles. Certain four-jet events are a special prize, because they might signify the production and decay of pairs of hypothetical particles predicted by extensions of the Standard Model. But some of the four-jet events the researchers did find didn't fit any predicted pattern (*Science*, 26 April 1996, p. 474).



JOHN THOMPSON/ALEPH

True colors? In this view down the LEP beamline, four jets of particles *(colors)* spray from a collision in the ALEPH detector. The odd pattern of jet masses could point to new physics—or to an experimental artifact.

At first, many physicists were inclined to dismiss these first few events as a fluke that would vanish with more data when LEP restarted late in 1996. But now that these new LEP runs, at energies of 161 GeV and 172 GeV, have been completed, "a few more events have come along. When it's all added together, this effect looks more significant, so this is what's now creating the excitement," says ALEPH researcher John Thompson of the Rutherford Appleton Laboratory near Oxford in the U.K., who in mid-December presented the ALEPH events to a meeting of about 100 theorists there. Thompson and his colleagues think it's unlikely that they've made a mistake, but theorists say it's equally hard to accept that ALEPH is seeing new physics where none is expected.

The Holy Grails of particle physics are the Higgs particle—responsible for the way particles acquire mass—and evidence for supersymmetry, a hypothetical higher symmetry in nature in which known particles would have massive partners. "If it were to have a Higgs-like interpretation, we would expect these four jets to have [a different] character," says Thompson. Supersymmetry also appears to be a long shot. In the ALEPH events, the visible collision products seem to account for all the collision energy, "which flies in the face of supersymmetry," says Thompson. "Except for some of the more obscure supersymmetry models," he explains, supersymmetry predicts an energy shortfall.

Wagner and his colleagues at CERN have already submitted a paper that explores one possibility: that the events signal a variant of supersymmetry in which particles with left- and right-handed "spin" can interact differently. They speculate that two supersymmetric electrons, having masses of 48 GeV and 58 GeV, could have briefly materialized in the collisions before decaying into the four jets. But Wagner too advises caution. "Right now, we cannot be sure that this is new physics," he says.

The LEP experimental groups have joined forces in an attempt to resolve the matter, looking for features of the detectors that might explain why ALEPH sees something while the others do not. They are also examining ALEPH's data processing, including the algorithms that pick out the jets. So far, says Dornan, "we don't have an algorithm that will kill it."

What may finally settle the issue is more data, which will come when LEP begins its new runs in May 1997. In the meantime, physicists face a frustrating waiting game. As Frank Close of the Appleton Laboratory puts it, "You can't tell yet whether this is the emergence of a signal, like the tip of an iceberg, or whether it's a small piece of ice that's going to melt away."

–Andrew Watson

Andrew Watson is a science writer in Norwich, U.K.

MATERIALS SCIENCE

Researchers Construct Cell Look-Alikes

From cells to shells, biological systems are masters of organization, assembling molecules into structures of ever larger sizes. Scientists looking to imitate this talent have had little trouble getting molecules to arrange themselves into the simplest components—for instance, coaxing layers of fat molecules, or lipids, to curl into tiny spheres, called liposomes. Yet, when it comes to assembling complex structures, biology leaves the imitators behind. But now, scientists from the University of California, Santa Barbara (UCSB), have displayed more than a little organizational prowess, assembling groups of lipid molecules into structures resembling cells, with an outer membrane encasing a series of vesicles.


S. WALKER AND M. KENNEDY/UCSB

Tiny bubbles. Vesicles packaged inside a fatty membrane.

The new work, which was presented last month at the Materials Research Society meeting in Boston, "is a very nice approach to making hierarchical materials," says David Grainger, a chemist at Colorado State University in Fort Collins. The cell look-alikes, dubbed vesosomes, may also boost efforts to use lipid spheres for delivering drugs to tumors and other tissues, says Theresa Allen, a drug-delivery specialist at the University of Alberta in Edmonton. The spheres deliver the drugs as they leak through lipid membranes. Packaging the drugs inside two membranes could slow the release of the drugs, lengthening the time between injections for patients.

To create the vesosomes, the UCSB researchers—materials scientist Joseph Zasadzinski and graduate students Scott Walker and Michael Kennedy—took a two-stage approach. First, they built and grouped together small lipid spheres, then shrink-wrapped the groups in an outer lipid membrane. The first part was easy. Researchers have been making liposomes for years by adding lipids to water and then blasting the solution with sound waves, among other techniques, to induce the fat molecules to assemble into spheres.

Tethering together a cluster of the minispheres was trickier. Liposomes don't usually group together; like charges on their surfaces, for example, often push them apart. So the researchers engineered special, two-part chemical linkers into the outer surface of the liposomes. First, they took some lipid molecules and attached one half of the chemical linker—a small, organic molecule known as biotin. Next, they mixed these with undoctored lipids. When the lipids then assembled into spheres, each had biotin molecules poking out of its surface. Then the scientists spiked the mix with the second half of the chemical linker—streptavidin. Each streptavidin can bind four biotins. This multiple binding drew free vesicles together into big aggregates. They were so large, in fact, that to package them, the team had to cut them down to size by forcing them through an ultrafine filter. The result: tethered groups of liposomes measuring 0.3 to 1 micrometer across.

To shrink-wrap the groups, Zasadzinski and his colleagues again used a two-stage process, first linking the liposome groups to the shrink-wrapping material and then causing it, through chemical sleight of hand, to wrap around the liposome groups. For their wrapping material, the researchers used lipids organized into a different form: sheets rolled up into tiny cylinders. Researchers have been coaxing lipids into cylinders as well as liposomes for years, but those made by the UCSB researchers differed in one key way: They engineered biotin and streptavidin linkers into the cylinders' surfaces. So when the researchers stirred up a soup of cylinders and liposome groups, the linkers again drew the structures together.

The final challenge was getting the cylinders to unfurl so the carpetlike sheets could form large sacs around the groups of smaller spheres. To pull this off, the team loosened some of the calcium bonds holding the cylinders together by adding to the mix a calcium-grabbing compound—ethylenediaminetetraacetic acid. As the cylinders unroll, about 15% naturally wrap themselves around neighboring aggregates, reports Zasadzinski.

Currently, the researchers are trying to improve the efficiency of the shrink-wrapping process. They also plan to see whether their two-membrane vesosomes do, in fact, release encapsulated drugs more slowly than do single-membrane liposomes. Allen notes, however, that as drug deliverers, vesosomes have a few drawbacks. For one, streptavidin is a bacterial protein that could trigger an immune response if injected into a person's bloodstream, she says. Also, she adds, at about a micrometer across, today's liposomes are big enough that they would be cleared quickly from the bloodstream by filtering mechanisms in the liver and spleen.

Zasadzinski says, however, that it should be fairly easy both to replace the streptavidin with nonimmunogenic compounds, as well as produce vesosomes that are tiny enough to remain in circulation. If he's successful, drug delivery experts may soon attempt their own bit of advanced biomimicry.

–Robert F. Service