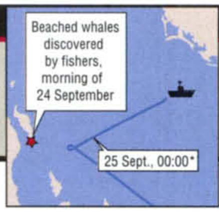
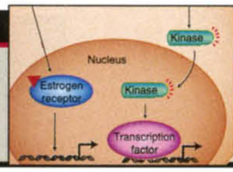




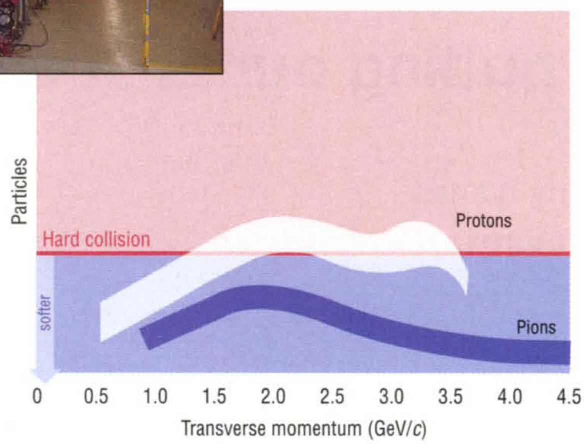
HIGH-ENERGY PHYSICS

Wayward Particles Collide With Physicists' Expectations

EAST LANSING, MICHIGAN—Physicists' quest for a new state of matter has taken a bewildering turn. At a meeting here last week,* researchers from the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory in Upton, New York, announced results that, so far, nobody can explain. By slamming gold atoms together at nearly the speed of light, the physicists hoped to make gold nuclei melt into a novel phase of matter called a quark-gluon plasma. But although the experiment produced encouraging evidence that they had succeeded, it also left them struggling to account for the behavior of the particles that shoot away from the tremendously energetic smashups.

"The more I think about it, the more I think it's not completely wacko," William Zajc of Columbia University, spokesperson for one of the four particle detectors at RHIC, said privately at the conference. Zajc ruminated for a few moments and then corrected himself. "Well, it *is* completely wacko," he said. "We don't get it. I really don't know—on a fundamental level."

The confusion comes from PHENIX, one of the four detectors, which probed the differences between "hard" and "soft" nuclear collisions. Nuclei are collections of protons and neutrons, and at low energies, they behave like hard objects. Smash one nucleus into another, and the components scatter like billiard balls. But scientists think they behave differently in very high-energy collisions. Neutrons and protons are made up of particles known as quarks and gluons, and at very high temperatures and pressures these particles should burst their bindings and roam free, forming a state of matter known as a quark-gluon plasma. In that case, theory predicts that the particles in the smashup would no longer bounce cleanly off one another; the melted mess would be sloppier, the particles splashing off one another like droplets of water instead of rebounding like chunks of ice. By analyzing the sprays of particles created by colliding various atoms, the RHIC physicists hoped to determine whether collisions become softer as the nuclei get bigger and carry more energy—a sign of a quark-gluon plasma, a state of matter that hasn't existed since the big bang.



Hard riddle. At the Relativistic Heavy Ion Collider (*top*), protons and pions born from the same explosions inexplicably show earmarks of different origins.

Last year, RHIC seemed to be seeing just that. For example, trackers found proportionately fewer high-momentum particles spraying away from powerful gold collisions, a phenomenon known as jet quenching (*Science*, 26 January 2001, p. 573). Although jet quenching could be due to some new, subtle effect caused by the particles' travels through dense nuclear matter, it is consistent with the creation of a quark-gluon plasma: The particles slow down as they fly through the sticky, soft goop in a plasma, rather than merely ricocheting off the components of the nucleus.

This tidy picture has just become considerably messier. With the higher energies and better statistics of RHIC's second year of running, physicists could classify the particles zooming away from the collisions. What they saw was a shock.

Measurements at PHENIX indicate that some of the particles flying away from the smashup are moving more slowly than normal, as one would expect in a soft collision, but others are caroming out of the wreck as if from a hard collision (see figure). Scientists know of no plausible mechanism for this discrepancy. "It's a true puzzle," says Zajc.

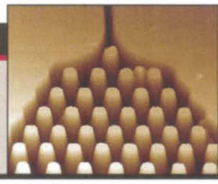
Part of the problem is that most of the particles PHENIX detects are born after the collision—spawned from more or less identical quarks and gluons (collectively dubbed "partons") that scatter off one another at the moment the two atoms crash together. The flying partons only then recombine into two-quark or three-quark ensembles ("hadrons," such as protons and neutrons). Because identical partons are doing the scattering, the hadrons they produce should all look as if they were born in the same sort of collision, soft or hard.

But that isn't what PHENIX sees, says Julia Velkovska, a Brookhaven physicist who is also associated with the PHENIX experiment. Pions, two-quark ensembles made of up and down quarks and antiquarks (and a handful of gluons) bound in an uneasy package, "behave more or less exactly like predicted" for a particle traveling through a sticky medium like a quark-gluon plasma, she says, whereas protons and antiprotons, three-quark ensembles also made of up and down quarks and antiquarks (and a handful of gluons), behave as if they were formed by a hard collision.

"Gee whiz," said Sean Gavin, a theorist at Wayne State University in Detroit, Michigan, when told of the results for the first time. "That's really interesting." But so far neither he nor anybody else can account for the difference. Zajc suggests that exotic gluon configurations might make two-quark ensembles (mesons such as pions) behave differently from three-quark ensembles (baryons such as

* 2002 fall meeting of the American Physical Society's Division of Nuclear Physics, 9–12 October.

CREDITS: (TOP TO BOTTOM) BNL; RHIC



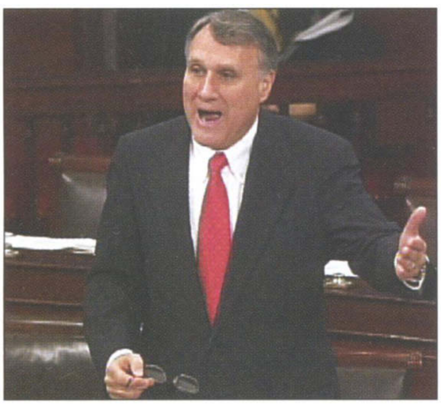
protons). Velkovska says that perhaps a parton flying away from a collision somehow "knows from the beginning that it's going to be a baryon." But both admit that these are wild guesses at the moment.

James Thomas of Lawrence Berkeley National Laboratory in California, who works with the RHIC detector called STAR, says that data due to be collected in 2004 will reveal whether a similar pattern holds with heavier baryons and mesons, such as the lambda baryon and the K meson. The next RHIC run, however, will collide deuterium with gold and protons with protons—a lower energy regime than gold-on-gold collisions. If the anomaly disappears under these lower energy conditions, physicists will be much more confident that this effect and others stem from the formation of some sort of dense plasma, rather than from partons traversing the nucleus. –CHARLES SEIFE

NATIONAL SCIENCE FOUNDATION

White House Concerns Block Doubling Bill

Call it a case of double or nothing. Legislators thought they had worked out a deal to authorize a 5-year doubling of the National Science Foundation (NSF) budget, a cherished goal of science lobbyists, as part of a comprehensive bill covering myriad NSF programs. But a last-minute objection from the White House sent lawmakers home last week with nothing to show for their efforts. Angry legislators from both parties accuse the Office of Management and Budget (OMB) of sabotaging the long-awaited agreement, which lobbyists hope can be salvaged when Congress returns after the 5 November elections.



Hold on. Senator Jon Kyl (R–AZ) is apparently in no hurry to double NSF's budget.

CREDITS: (LEFT TO RIGHT) AP PHOTO/APTN; MICHAEL LEACH/PHOTO RESEARCHERS; CORBIS

The money to run an agency comes from appropriations bills, most of which are still pending 1 month into the 2003 fiscal year. But authorizing legislation provides detailed and binding instructions on how an agency should operate. The House of Representatives passed its version of the NSF authorization bill (H.R. 4664) in June, a 3-year blueprint with annual increases intended to put NSF's current budget on a doubling track. Last month two Senate panels approved a different version (S. 2817) that provided for a full doubling, to nearly $10 billion, by 2007. In addition, the bills require NSF to publicly rank proposed major research facilities and give greater hiring and budget autonomy to the National Science Board, NSF's presidentially appointed oversight body. NSF Director Rita Colwell had previously raised strong objections to both items (*Science*, 27 September, p. 2187).

Although the full Senate has yet to vote on the measure, on 10 October House and Senate negotiators resolved their remaining differences and prepared for a pro forma vote by each body on identical bills. But on 16 October Senator Jon Kyl (R–AZ) raised a parliamentary objection, blocking a vote in the Senate. Sources say that his "hold" reflects OMB's concerns that a 5-year doubling is arbitrary—a point science adviser John Marburger has made repeatedly—and runs counter to the Administration's long-term budget strategy. Congressional aides nevertheless feel that they were blindsided; they say the Administration never formally objected to the provisions. "It came up at 11:59 p.m.," says one frustrated staffer. "And now it's 12:01."

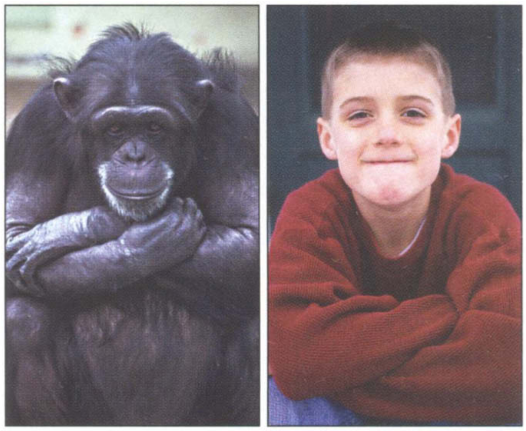
Congress is now weighing an OMB counterproposal that shortens the bill to 3 years and removes the word "doubling" from its title. But although that might be acceptable to some members, it rankles others. "It's a doubling bill," says one aide. "And it's not a random increase; we were very careful to spell out our priorities."

In fact, the 91-page bill discusses several NSF programs in great detail. The annual ranking of proposed research facilities, for example, is intended to clear up the community's confusion over the status of various projects that the board has approved but for which NSF has not requested funding. And the science board provisions are meant to ensure that the NSF director does not wield undue influence over the board. "The board can certainly live with the provisions in the authorization bill," says board chair Warren Washington, a climate modeler at the National Center for Atmospheric Research in Boulder, Colorado. Washington says that the board is already developing a ranking of pending facilities projects and hopes to polish the list at its 20 November meeting. –JEFFREY MERVIS

EVOLUTIONARY GENETICS

Jumbled DNA Separates Chimps and Humans

BALTIMORE, MARYLAND—For almost 30 years, researchers have asserted that the DNA of humans and chimps is at least 98.5% identical. Now research reported here last week at the American Society for Human Genetics meeting suggests that the two primate genomes might not be quite as similar after all. A closer look has uncovered nips and tucks in homologous sections of DNA that weren't noticed in previous studies.



Loosened family ties. Gene-chip studies reveal previously unrecognized differences between these two species.

The results are quite exciting, says Michael Conneally, a human geneticist at Indiana University Medical Center in Indianapolis. With this research, "we can really find out so much more about evolution," he predicts.

In the past 3 decades, biologists have used all sorts of biochemical methods to assess differences between genomes, particularly those of humans and chimps. As more DNA sequence became available over that time, many researchers began to look at short stretches of DNA and count the number of single bases that didn't match the equivalent bases in another species—