consideration. Per Clausen, president of the academics' union, the Magisterforeningen, says: "In principle we regard the science department's handling of the situation as the only proper response, but at the same time it is clear that blocking staff renewal will badly hurt the university and its research."

Indeed, research is already hurting. Several research groups have been reduced to the point that ongoing projects have effectively come to a halt. For example, one group in the department of genetics investigating the silencing of chromatin has been shut down after 4 years of successful work because the tenure of its leading assistant professor has been canceled. Science teaching will also be seriously hit, because courses are largely taught by assistant professors and junior associate professors. Leif Søndergaard, an associate professor of genetics, says that "because of the cuts, many courses will no longer be offered every year and others will be generating waiting lists."

Young researchers are now beginning to make their voices heard. Østergaard has sent a highly critical letter, signed by 90% of the graduate students and postdocs in the department of molecular biology, to the *Copenhagen University Journal*. Among other things Østergaard describes a widespread feeling that "the university is shooting itself in the foot by not identifying and getting rid of those researchers whose scientific contribution is minimal."

–LONE FRANK

Lone Frank is a writer in Copenhagen, Denmark.

PARTICLE PHYSICS

DESY Puts the Spin Into Gluons

In the microworld of subatomic particles, metaphors quickly reach their limits. Quarks, the building blocks of protons and neutrons, are held together by a haze of force-carrying particles referred to as subatomic "glue." But it now appears that, unlike any glue in the macroworld, these gluons have a property known—metaphorically, again—as spin.

The finding, reported last week at a Moriond meeting* in the French Alps by physicists from DESY, Germany's particle physics lab near Hamburg, is a step toward solving a long-standing puzzle about protons and neutrons, collectively called nucleons: What gives these particles their spin? The three quarks that permanently inhabit a nucleon only appear to contribute a small part of its spin. The swirling sea of "virtual" quarks, which flash in and out of existence inside each nucleon, seem to add even less, and the total contribution by all the quarks is only 30%. That leaves the gluons. "The question of how much of the proton spin is carried by gluons as compared to quarks has been at the forefront of people's minds for the last several years," says Frank Close of Britain's Rutherford Appleton Laboratory. Now, a new technique for reaching into protons and gauging the spin of their gluons has yielded evidence that gluons do indeed carry part of a nucleon's spin, although the precise amount isn't clear.

Studying the interior of nucleons is not easy, and some of the world's largest particle accelerators have been involved in this endeavor, including machines at the CERN particle physics center near Geneva, the Stanford Linear Accelerator Center in California, and DESY. Physicists use these accelerators to smash beams of leptons—pointlike charged particles such as electrons, positrons, and heavier electronlike muons—into targets containing protons. Occasionally a lepton exchanges a force-carrying photon with a quark inside a proton and scatters off it.

In these experiments, both the leptons and the protons are spin-polarized: Their spins are aligned in one specific direction. From the way the scattering probabilities change when the spin of the particle beam or the target is reversed, the physicists can calculate the spin contributed by the quarks. Until now, however, the gluons inside protons have escaped scrutiny simply because they are not charged and so cannot interact with leptons electromagnetically, via a photon.

But the researchers who operate the HERMES detector on DESY's Hadron-Electron Ring Accelerator (HERA) reported at the Moriond meeting that they had followed a suggestion put forward by other European researchers and looked at a different interaction between gluons and a probe beam of positrons, known as photon-gluon fusion. As positrons enter a proton, some are strongly decelerated by its charge, causing them to shed high-energy photons in a process known as bremsstrahlung. "The photon comes in, materializes as a quark-antiquark pair, and one of these quarks scatters from the glue," says HERMES spokesperson Edward Kinney of the University of Colorado, Boulder. So a combination of electromagnetism and the strong nuclear force is responsible for the scattering.

Quarks can't be detected directly, but after scattering they disintegrate into a stream of other particles, which can be picked up by particle detectors. Because the quarks produced by the bremsstrahlung photons retain the polarization of the original leptons, their probability of being scattered in a given direction depends on the gluons' spin. The results so far—an analysis of collision data collected in 1996–97—indicate that gluons do carry spin. But so far, says Kinney, "we cannot conclude from our data what the total contribution of the glue is to the nucleon spin."

Dietrich von Harrach of Mainz University in Germany, one of the physicists who is studying similar data from the SMC collaboration at CERN, adds that interpretation of these streams of particles can be tricky. Instead of resulting from photon-gluon fusion, he says, they may be generated when one of the relatively low-energy positrons in HERA's beam exchanges a photon with a quark, which then emits a gluon, a process called Compton scattering. "The predominance of the Compton process over pair production may be a real problem," he says. However, von Harrach expects that the muon beams in CERN's COMPASS experiment, now under construction, will have high enough energies to remove that ambiguity and make a definitive measurement of the spinning glue of the microworld.

–ALEXANDER HELLEMANS

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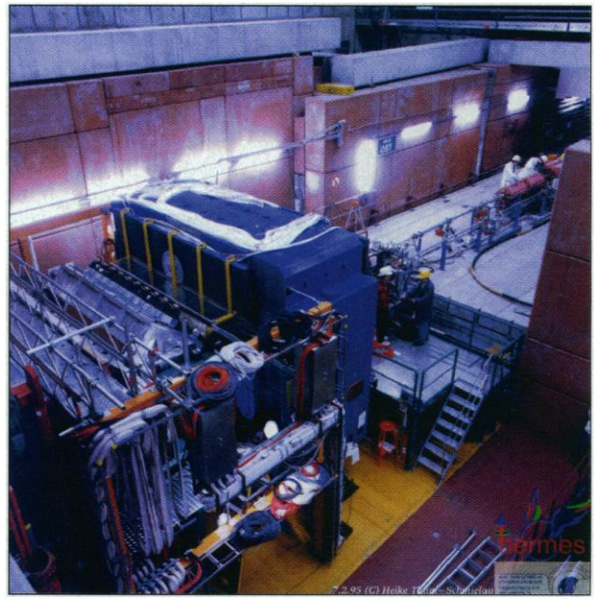

Spin center. The HERMES detector at DESY first uncovered evidence that gluons have spin.

CREDIT: HEIKE THUM-SCHMIELAU/DESY

* Rencontres de Moriond, QCD and High Energy Hadronic Interactions, Les Arcs, Savoie, France, 20 to 27 March.