

## Scientists spin protons to learn their secrets

Suppose you made two tops, both spinning in the same direction, collide with each other—and they bounced off at some angle.

Then suppose they were spinning in opposite directions. Instead of colliding and bouncing apart, each just continued along its way, as if the tops had passed through each other.

How would you account for that?

That's essentially the problem facing University of Michigan physicist Prof. Alan D. Krusch. Only his experiment, conducted at the Argonne National Laboratory near Chicago, deals with rapidly spinning protons instead of tops.

Krusch is leading a group of high-energy physicists from Michigan, Argonne, Oxford, and Copenhagen in an effort to learn more about the nature of the proton, a tiny building block in the nucleus of the atom.

"There is fairly widespread evidence that the proton has some sort of constituents, but little information as to exactly what they are like," he explains. "We are quite surprised—

even shocked—by the results of this experiment."

Funded by the Energy Research and Development Administration, the experiment was conducted using Argonne's Zero Gradient Synchrotron (ZGS) accelerator—a huge machine about 600 feet in circumference and buried under a hill about 100 feet high.

The Argonne ZGS is the only high-energy accelerator in the world that allows the observation of spin-spin forces—a capability developed during 1970-74 by a group of Michigan and Argonne scientists, many of whom are working on the new experiment.

Krusch explains that the protons move around the accelerator about a million times in a second, each time gaining energy until they have about 12 billion electron volts of energy (12GeV). They are then going at 98.5 per cent of the speed of light.

"The experiment ran three months, seven days a week, 24 hours a day," he notes. "During this time the target was bombarded with ten billion polarized protons every four seconds."

There are several theories about the nature of protons, some developed by members of this project. In 1966 the team working at the ZGS found evidence that the proton consists of a single "core," or small dense cloud of matter at the center, with a larger semi-transparent cloud as an outer layer.

Recent results suggest that those layers spin around each other at different speeds, resembling a "spinning onion."

"Some other physicists think that each proton is made of three 'quarks' or 'partons' that evolve around each other like a triple binary star system," Krusch adds.

"We simply need more information before we can say who, if anyone, is right."

So what does this experiment show? "It seems to indicate that the hard scattering—bouncing apart—of the protons rarely occurs unless both protons are spinning in the same direction," Krusch says.

"Perhaps the quarks in a proton only scatter when their spins are parallel. Or perhaps the inner dense clouds only have violent head-on collisions when the spins are parallel—but when they are spinning in opposite directions they become 'transparent' and pass through each other."

"Both these ideas seem quite strange."

For the moment, he will only conclude that, as his earlier work indicated, protons seem to consist of something other than solid matter. More experiments are needed to understand the substructure of the proton.

"We hope to extend these measurements to even more violent collisions," Krusch reports. "Then we'll see if the same kind of thing keeps happening."



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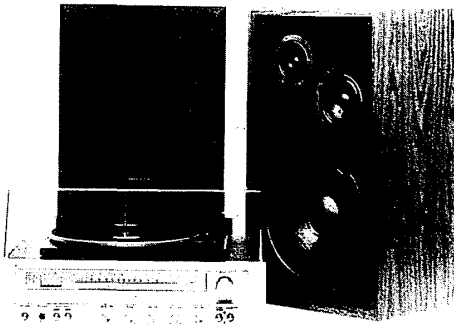


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