

Holism and particlism in physics

Physicists do not like the idea of instantaneous action at a distance. If one object influences another, the objects should be in contact. If they are far apart, some physical intermediary should go between them, and the intermediary should take some time to cross the distance. Physics is a pool table, and there is always a cue ball.

Lately, however, it seems there *are* cases of instantaneous action at a distance. Alain Aspect of the University of Paris-South at Orsay, France, and his collaborators have done a series of experiments that seem to show that phenomena known as quantum mechanical correlations do exist (SN: 1/11/86, p. 28). The conventional interpretation is that these correlations involve action at a distance. Opponents of action at a distance are interpreting them in a different way, and one of these opponents, Jean-Pierre Vigiér of the Institut Henri Poincaré in Paris, plans an experiment he believes will show his view to be correct.

Quantum mechanics predicts that under certain conditions an atom will emit a pair of particles with correlated properties—for example, two photons with opposite polarizations or two neutrons with opposite spins. The prediction says the particles will maintain the correlation no matter how far apart they move in space and time. To maintain the correlation, it looks as if the particles have to be in constant (and therefore instant) communication with each other. The left always knows what the right is doing. This is what Aspect and his colleagues seem to have found.

Albert Einstein called such phenomena *spukhaft* (spooky). Those who follow his lead want to exorcise the spooks, and Vigiér does so using a theory largely associated with the name of David Bohm of Birkbeck College of the University of London in England. This theory puts back the cue ball in the form of a quantum potential that mediates information between the two correlated particles. A potential is a condition of space that gives rise to physical effects.

Potentials are often used as intermediaries in relations over distances. For example, the moon feels certain forces and moves in a certain way because of the gravitational potential generated by the earth. Potentials do not exist instantaneously and everywhere in space. If a source is turned on, if a body suddenly becomes electrically charged, for example, an electric potential will propagate itself into space from the object.

The Bohm quantum potential comes from the basic equation of quantum me-

chanics, the Schrödinger equation. It is primarily a carrier of information. For example, it will tell a particle which of several possible trajectories to take. In the correlation case it supplies the informational contact that maintains the correlation. To do this it has to propagate itself faster than light, at 7.57 times the speed of light, to be precise.

Thus the quantum potential violates the precept of special relativity that nothing goes faster than light, but it saves a more important principle: the reductionism of physics. Niels Bohr said correlations indicate a certain wholeness in quantum mechanical phenomena, standing connections over long distances in time and space. If that is so, and Aspect's experiments seem to indicate it, physicists would no longer be sure they could analyze a given physical system into its parts and study the parts in isolation. This is the way scientific investigation has proceeded since the days of Demokritos of Athens, but it may now have reached a stop sign. The whole may have properties that do not result from the sum of the parts. This holism-reductionism crisis caused consternation at last week's meeting in New York on New Techniques and Ideas in Quantum Measurement, sponsored by the New York Academy of Sciences. Many physicists seem unsure what to do.

Vigiér plans an experiment involving neutron interference, he told the meeting. Neutrons are usually thought of as particles, but they do behave like waves. If a beam of neutrons is split in two and sent on different paths and then recombined, the two halves will be in or out of phase with each other according to whether the two paths were equal or not.

The beam can be reduced until there is only one neutron in the apparatus at a time. Even so it interferes with itself. Which path—if any—did the single neutron take? The Bohrean view would say that the wholeness of things makes it impossible to talk about paths: Neutrons don't really move around like particles in space and take particular paths. The Einsteinian view says they do: The neutron takes one of the two paths even though it interferes with itself like a wave. The Bohm potential should tell which, and Vigiér intends to show it by putting an electrical coil around one path. The coil will reverse the spin of the neutron, and in consequence the neutron will give the coil a tiny quantum of energy. Measuring that energy will tell if the neutron took that path or the other. Vigiér plans to do the experiment at a reactor in Grenoble, France.

— D.E. Thomsen

EPA moves to phase out asbestos goods

The Environmental Protection Agency (EPA) last week proposed banning five widely used asbestos products, then phasing out over 10 years all mining, importation and remaining uses for the mineral. A known human carcinogen, asbestos is capable of causing lung cancer and mesothelioma (a cancer of the chest and abdominal lining). In announcing the proposal, EPA Administrator Lee M. Thomas said that enacting the law could ultimately prevent about 1,900 U.S. asbestos-related cancer deaths.

EPA only began investigating the hazards posed by some of the now-to-be-banned products after French researchers in 1982 pointed out that asbestos-impregnated floor tiles could, through normal wear, release "important" concentrations of the mineral into the air (SN: 7/10/82, p. 22). In addition to vinyl-asbestos floor tile, the new proposal would immediately ban asbestos-containing roofing felts, flooring felts and felt-backed sheet flooring, cement pipe and fittings, and clothing. These products account for an estimated 40 percent of the U.S. asbestos market.

The remaining products would have to be labeled as containing asbestos. EPA is also considering several alternatives for such products. One would ban all construction and clothing uses now, all friction (brake) products within five years and everything else within 10 years. Another would ban clothing and construction products now and phase out the rest over 10 years.

At issue is how quickly substitutes can be found for those products—such as asbestos brake linings—not immediately banned. Its high traction and resistance to chemical and thermal breakdown make asbestos ideal for brakes. Though semimetallic materials have been substituted for asbestos in front disk brakes, they provide less traction when new. Using them in rear drum brakes would therefore require redesigning the brake so that it could meet new-car parking-brake standards and not risk becoming overly susceptible to lockup once it wore in and became stronger, according to Robert LeFevre, manager of safety standards on General Motors Corp.'s Environmental Activities Staff in Warren, Mich. In short, LeFevre says, "We do not have materials today that we could substitute for asbestos linings that would allow us to build vehicles that meet the brake standards in place"—though "we ought to be able to do it within 10 [years]."

Nonasbestos substitutes for the five products initially banned under this proposal would cost an estimated \$1.8 billion—or less than \$10 per consumer over 15 years, EPA says.

— J. Raloff