One quark knows the other quark's charge

Physical theory endows quarks with a rapidly increasing variety of properties and characteristics. Quarks are — in theory — the basic constituents of matter, the objects out of which the fundamental particles of physics (for example, the proton and neutrons that make up atomic nuclei) are built. Quarks must possess the necessary properties in the exact amounts so that when they are added together in the theoretically prescribed ways, the particles that are constituted by the different kinds of summation come out with the properties they are observed to have.

Finding out whether quarks really have the postulated properties, even something as basic as electric charge, is not easy. Quarks never appear in such a way that they can be detected and measured as free particles. They tend to stay within the confines of the structures they build. Within those confines they may be exchanged, altered or multiplied, but getting information about what goes on in there depends on indirect observation at best.

In the Feb. 12 NEW SCIENTIST is a report that physicists working at the Deutsches Elektronen-Synchrotron laboratory (DESY) in Hamburg seem to be deriving evidence that quarks do have electric charge. The evidence comes from studying collisions of electrons and positrons in DESY'S PETRA storage ring.

In the ring, highly energetic electrons collide head-on with highly energetic positrons. Positrons are the antiparticle to electrons, so the collisions constitute annihilation reactions that yield blobs of pure undifferentiated energy. This energy can then articulate itself into just about any form of physical particle. Sometimes it turns into a quark and an antiquark.

This quark and antiquark are not allowed to travel any farther than the equivalent of the diameter of one of the particles they could be a part of. Before they leave that volume the individual quarks must become something else.

These are a very energetic quark and antiquark so each of them changes itself into quite a spray of ordinary particles. (In the convoluted world of particle physics it is possible for a thing that has a lot of energy to turn itself into its own container, not once but many times.) The particles produced come off in oppositely directed jets, one for the quark, one for the antiquark.

The physicists working with DESY'S TASSO detector have been recording quite a few of these two-jet events that are attributed to quark-antiquark production, and they notice a curious thing about the distribution of electric charge among the particles in the jets. It is not random.

The original meeting and annihilation of electron and positron produces an electrically neutral bit of energy. If charged particles are subsequently produced from this bit of energy, the total charge, the sum

Artichoke guards: Plume moth confusion

It only takes a single chemical to excite a male plume moth. A whiff of 11-hexadecenal sends him, antennae raised and wings vibrating, in search of a mate. Traps with only 100 micrograms of the synthetic pheromone catch more male moths than do traps with four attractive virgin females, report Kenneth F. Haynes and Martin C. Birch of the University of California at Davis and Jerome A. Klun of the U.S. Department of Agriculture. The researchers speculate that the entire 10,000 acres of the California globe artichoke crop could be treated with the pheromone as a test of the "male-confusion" technique for insect control. Against a high background of the chemical most male moths would be unable to locate virgin females for mating and the population would decrease, the scientists predict. Then artichoke growers could get off the current insecticide treadmill.

Although the artichoke crop has only one important insect pest, the battle against that pest has been costly. A large number of insecticides are currently sprayed on the crop, at a cost of approximately $300 per acre. Consequently, the artichoke plume moth has developed some pesticide resistance and normal biological controls have been disrupted. The moth originally infected thistle plants, but when it was introduced to California in the 1920s, it took up residence in artichokes. In some harvests as many as 90 percent of the buds have been infested by the moth larvae and recent annual losses have been as high as 50 percent of the bud crop, Haynes and colleagues say in the January CALIFORNIA AGRICULTURE. Even if the pheromone does not control the plume moth population by male confusion, it is expected to cut down on insecticide use. It can be used more conveniently than can virgin females in field traps so that more limited applications of insecticides can be appropriately timed. □

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Virgin females evoke male mating behavior by a single chemical released from a gland that extends from the tips of their abdomens (arrow).

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