More fractional electric charge

Since the earliest days of subatomic physics it has been clear that electric charge is quantized. There is a certain measurable amount of charge that is the minimum a body can have. It has either that much charge or none, no amount in between. Larger charges come in integral mutiples of the minimum. The quantum of charge is the amount of charge on the electron, and in fact no subatomic particle has ever been found that has less. So it has been for as long as the century has run.

Yet it was not a shock but merely a sensation when a group of researchers at Stanford University, William M. Fairbank, George S. LaRue and Arthur F. Hebard, reported about two years ago (SN: 4/30/77, p. 276) that after twelve years of work they had succeeded in finding a rather large niobium ball (large compared to an electron) that carried only one-third of the electron's charge. But once is not enough, and they went back to look for more. Now LaRue and Fairbank and James Douglas Phillips report in the Jan. 15 Physical Review Letters that they have found two more.

The original finding was not a shock because there was already a prediction that such charges should exist. It is contained in the quark theory of the structure of subatomic particles, which says that the known particles are made of subunits called quarks and that these quarks have charge in amounts of one-third and two-thirds the electron's charge. It doesn't dequantize charge, but it changes the size of the quantum. No individual quark has ever been seen as a free particle. In the absence of such direct evidence the finding of one-third charges on larger bodies might be indirect evidence for quarks.

The experiment takes niobium balls, which become electrically superconducting when chilled to near absolute zero and can be made into a kind of perpetual magnet, and levitates them in a vacuum with electric and magnetic forces. Such balls almost always have a certain small charge to start, so the experiment is to bombard them with electrons and positrons (unit charges, negative and positive) until zero is reached. If there remains any fraction of charge that cannot be neutralized by successive application of +1 and −1, it can be measured by the force necessary to hold the ball in position against gravity. The original version of the apparatus allowed the researchers to discount the possibility that fractional charges could have been caused by vertical electric forces. Improvements now allow them to rule out horizontal ones as well. "Calculations indicate that no other electric or magnetic force could have mimicked the fractional charge," they state.

The existence of fractional charge, if it continues to hold up, may or may not be evidence for the existence of quarks. Whatever it is, it will be revolution enough in electromagnetics. □

Electric pain control: It's endorphin

When Charles Niethold fell at work in 1975, he seriously injured his back for the second time. He had already undergone two operations and now a third left him in chronic pain, unable to walk without crutches. But last week he walked easily into a press conference at the University of California Medical Center in San Francisco to testify to the effectiveness of an electrical technique for pain reduction (SN: 6/17/78, p. 391). The reason for the conference was that Niethold's neurosurgeon, Yoshio Hosobuchi, believes he now can explain the physiological working of the pain relief method developed serendipitously a few years ago.

One of the body's "natural opiates," beta endorphin (SN: 1/25/78, p. 374), is the key to the pain reduction, Hosobuchi and colleagues conclude. To reduce chronic pain, Hosobuchi implants in the central part of the brain (the periaqueductal gray matter) wires that run to a radio receiver in the patient's chest. For pain relief, a patient simply holds the antenna of a small transmitter over the receiver in his chest. The pain subsides in a few minutes and may not recur for several hours or even days.

In their recent experiment Hosobuchi and his colleagues, Roger Guillemin, Jean Rossier and Floyd E. Bloom of the Salk Institute in La Jolla, examined cerebrospinal fluid from the brains of patients receiving electrical implants. The investigators obtained fluid through a catheter used in the surgery to inject dye as a guide for positioning the thin wires. For three patients with chronic pain that responds to narcotics, the first 15 minutes of electrical stimulation increased the concentration of beta endorphin to 2 to 7 times the level in the fluid at the onset of surgery. However, there appeared to be no increase in another natural pain-relieving chemical, leu-enkephalin. Another group, using a different detection method, has reported a moderate enkephalin increase in response to stimulation (SN: 6/17/78, p. 391).

Electrical stimulation has been used to relieve two kinds of chronic pain, and Hosobuchi's research, reported in the Jan. 19 Science, adds to the evidence that different mechanisms are involved. Beta endorphin release is implicated only in relief of the pain that responds to narcotics. Such pain may result from injury to peripheral nerve cells, as in Niethold's case, or from cancer.

Pain that cannot be alleviated with narcotics usually involves damage to the central nervous system, for instance from a stroke or from severing the spinal cord. In such cases, a neurosurgeon can implant wires going to a different part of the brain. These patients require constant electrical stimulation of a broad brain area. When Hosobuchi and co-workers examined three patients receiving such implants, they observed no increase in beta endorphin with electrical stimulation.

While the patient response to electrical implants can be dramatic, problems may also arise. Niethold, who received his implant prior to the present experiment, recalls that almost immediately after electrical stimulation began he was able to raise his leg from the operating table, a movement he had not been able to do previously. However, after that first implant, infection developed and one of the two electrodes in Niethold's brain had to be removed for a year. Of Hosobuchi's 80 patients with implanted electrodes, one has died as a result of infection. Still Hosobuchi concludes that stimulation of the body's pain-killing hormone by electrical means is generally safe and effective for patients with chronic pain who wish to avoid dependency on narcotics, particularly for those patients with pain in the lower extremities.

The electrical stimulation involving beta endorphin produces tolerance; as in narcotic treatment, patients require increasingly frequent "hits." (However, there is no narcotic euphoria.) Another recent discovery by Hosobuchi may eventually help drug addicts as well as chronic pain victims. He finds that increasing dietary tryptophan (an amino acid common in dairy products and nuts) reduces troublesome tolerance. For example, Niethold says that after he started taking tryptophan (which he buys in a "natural foods" store) the frequency of stimulation he required to reduce pain decreased.

Niethold also described a bonus of his treatment that was news to Hosobuchi: Niethold used his transmitter just before going to the dentist to ensure a painless tooth filling. □

Activation of electrical pain suppressor demonstrated by Niethold and Hosobuchi.