

SCIENCE NEWS OF THE WEEK

Evidence for Fractional Electric Charge

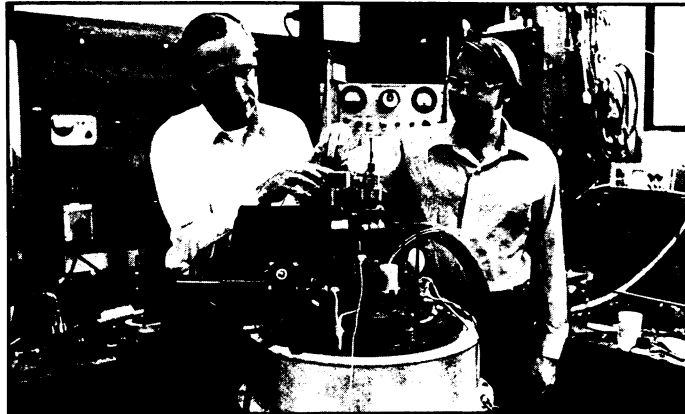
Ever since Robert A. Millikan first began to try to find the electric charge of the electron, physicists have been measuring and remeasuring the charges of subatomic particles and larger bodies. Until now no one has been willing or able to conclude that an electric charge could exist that was not equal to the charge of an electron or some integral multiple of it. It seemed a basic fact of nature that electric charge was quantized and that the basic quantum was the amount of the electron charge.

This week at the meeting of the American Physical Society in Washington, two physicists from Stanford University, William M. Fairbank and George S. LaRue, told a crowd that had literally crawled through the walls of the room (the folding partitions of a hotel ballroom) to hear that they had, in LaRue's words, "evidence for fractional charge." The evidence results from 12 years of work by Fairbank, LaRue and a third physicist, Arthur F. Hebard, now of Bell Telephone Laboratories. The result, if it is confirmed—and the next thing Fairbank and LaRue intend is to do a further series of measurements and to try to isolate the fractional charge from the ball and see what it is—is likely to stand as one of the most important experimental results in physics of this or any century.

In the seven decades or so since Millikan flourished, many experiments have been done to check the value of the charge quantum, which is an extremely important number for theoretical and experimental physics as well as many branches of technology. Some of those experimenters have occasionally seen data that looked strange, but they have been unwilling to place any reliance on them. Millikan himself recorded that he threw out one piece of data that seemed to indicate a measurement of about 0.30 of the electron charge because he could not quite believe it. Fairbank, LaRue and Hebard are the first who have the nerve to stand up and tell a room full of physicists that they believe such a result, although Fairbank is quoted in an announcement by Stanford University to the effect that "this discovery is tentative."

The basis of the experimental technique is in general the same as those of the many preceding experiments. One does not try to use individual electrons to measure. One takes a small piece of matter, in Millikan's case an oil drop, in others, a small ball of metal, and levitates it in electric or magnetic fields or both. The electric charge on the drop or ball is gradually reduced until it can be reduced no more. The charge can be measured by how much electric force is necessary to

Fairbank and LaRue adjust the cryogenic refrigerator in which they levitated niobium balls that may have had unbalanced quarks stuck to them.



Stanford University

make the ball float against gravity. The trick is to measure zero charge and then the nearest thing to zero that the ball will sustain.

In the Stanford case, the balls were of superconducting niobium and were 0.025 centimeters in diameter. Their charges were gradually reduced to zero by bombardment with electrons and positrons. Measurements of eight such balls yielded two instances in which the result was different from zero or one. One such seems to be about minus one-third of an electron charge, the other plus one-third. In one of these cases, LaRue says, subsequent measurement on the same ball gave a reading of zero, as though there had been a one-third charge on the ball that had later gone away.

The number one-third is highly suggestive. A well regarded theory says subatomic particles are built of subparticles called quarks. One version of this theory envisions quarks that have charges equal to one-third and two-thirds the electron charge. So a possible interpretation of the result, which is mentioned in the Stanford announcement, is that somehow an individual quark that did not form part of a subatomic particle had attached itself to the surface of the ball. Neither Fairbank nor LaRue explicitly made such an interpretation in his presentation, but many in the audience drew the conclusion. One question from the audience was: "How many free quarks per nucleon in the ball would that result make?" LaRue replied: "One in 5×10^{19} ."

The major difficulty with an experiment like this, and the main reason this one took 12 years, is that there are a host of background forces and disturbances, electric, magnetic, thermal and even seismic, that can foul up the measurements. Many of the odd results recorded in the past have been attributed to such disturbances. The burden of Fairbank's talk was to convince the assembled colleagues that the background had been either eliminated or properly discounted. The two talks were

greeted with loud applause, but the applause was followed by a rapid fire of sharp questions about the background forces, the techniques of measurement and the data analysis. At this point it is not clear whether the questioners were believers seeking reassurance, skeptics trying to poke holes or a mixture of the two. The majority response as the news spreads through the physics community will tell.

If the result of Fairbank, LaRue and Hebard stands up, and if it indeed involves loose quarks, it will reopen a number of important questions in the quark theory and also possibly some old lacerations in the hides of theorists. Up to now, theorists had just about convinced themselves that free quarks were impossible, that there were reasons involving the laws of their nature that prevented them from ever separating out of the structures of the particles they build. As R. R. Freeman of Bell Laboratories, who chaired the session, said in introducing Fairbank, "[He] will tell us how to get out of the bag, off the string and on the ball." The bag and the string are two analogies for the ways theorists have thought up to explain why quarks appear to be eternally stuck inside the structures they build and inherently unfreeable. □

A Martian muddle: DNA the dry way?

In the many months since the Viking spacecraft began reporting from the surface of Mars, only a single unified proposal has publicly emerged to attempt to account for the seemingly conflicting data from the landers' biology instruments. Developed by Vance Oyama of NASA's Ames Research Center (SN: 3/5/77, p. 149), it has so far achieved neither acceptance—nor competition. Now Oyama has dramatically extended his hypothesis: Although he believes that the Viking instruments have shown no signs of living

Martians, Mars itself, he says, may be in a pre-biotic state, perhaps with molecules as complex as DNA surviving on the surface. The idea, Oyama admits, takes him "way out on a limb," but if future studies prove him correct, the discovery could overturn accepted theories of the origins of life on earth.

Conventional wisdom, Oyama says, has it that life on earth began in the oceans, with a pre-biotic soup of nucleotides and amino acids combining to form DNA and proteins. Oyama, however, believes that DNA formed during an earlier dry period—"the cosmologists are willing to give me 100,000 years," he says—before the primordial oceans even appeared.

The hypothesis begins with carbon suboxide (C_3O_2), which plays a major role in Oyama's explanation of the Viking biology results. Past studies cited in the chemical literature, according to Oyama, suggest that carbon suboxide can combine with ammonia and carbon dioxide to form ring-shaped molecules similar to precursors of DNA components known as pyrimidines and purines. All of the pyrimidines and purines, he maintains, can be formed from these reactants—which he believes are or have been available on Mars—under Martian temperatures and the Martian solar-wind environment. Another important DNA component, sugar, comes, Oyama says, from the polymeric form of the carbon suboxide, hydroxylated by performate (which is formed in the atmosphere from CO , CO_2 and water under the sun's ultraviolet radiation).

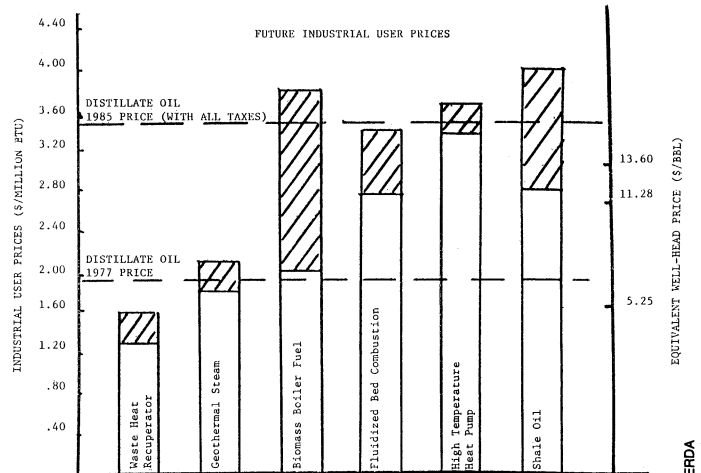
Oyama proposes that the ammonia was released into the Martian atmosphere from the breakup, during entry, of carbonaceous chondrite meteorites. The same source, he says, could have provided necessary phosphorus in a form that could combine with the precursors to link the DNA "subunits" together.

It is not possible to tell at present just where Mars stands in this complex process. The Viking lander instruments, Oyama points out, could not distinguish DNA molecules—only their components—and could miss even those if the amounts are small or irregularly distributed. Furthermore, the planet may be prevented by a variety of factors from advancing further toward the development of life. Future missions could seek DNA, however, and the idea that it could have formed "dry" would be revolutionary.

This is admittedly rather sensational stuff to have developed from such a young hypothesis, particularly one with so many unknowns. Its potential import is not too far out of scale, however, with possibilities envisioned by various researchers before the Vikings ever got to Mars. In a way, says Oyama, more stands to be learned about life's origins from the lack of Martians than from their presence. "Life," he says, "would gobble up its ancestral beginnings." □

Carter on energy: The R&D impact

New energy technologies would become economically feasible under Carter program.



President Carter's recently announced energy program would not only change the kinds of fuel Americans use and the way they use them but also shift substantially the emphasis of research and development aimed at providing energy for the future. If Congress approves, Carter's program would raise the price of oil enough to make several new technologies economically competitive (see chart) and would provide new R&D funds to speed these technologies on their way to market.

Robert Fri, the acting administrator of the Energy Research and Development Administration, announced the following changes in energy R&D funding that would be brought about by the President's energy strategy. The figures represent proposed changes in outlays between the fiscal 1978 budget announced in February (SN: 3/5/77, p. 150) and those resulting from the energy message:

- Conservation, \$4.5 million (1.8 percent) increase. ERDA would work with private industry to accelerate introduction of gas-fired heat pumps into the market and save the waste heat from ERDA facilities for commercial and residential use.

- Breeder reactor, \$62 million (9.5 percent) decrease. Construction of the Clinch River prototype breeder would be deferred indefinitely, but the experimental Fast Flux Test Facility would be completed.

- Solar, \$10 million (4 percent) increase. The increase would go to expanding engineering design efforts in photovoltaic systems and for acceleration of solar energy as power for space cooling.

- Thorium fuel cycle, \$12.5 million (625 percent) increase. Breeder reactors that convert thorium to uranium are considered less of a threat to nuclear proliferation than those that convert uranium to plutonium, which can be used in bombs.

- Uranium enrichment facilities, \$91 million (6.5 percent) decrease. The decrease reflects cancellation of a proposed gaseous diffusion plant in favor of a new gas centrifuge enrichment plant, which

should cost less and use less power.

- Fossil energy, \$12 million (2.3 percent) increase. The extra funds would provide for the design of a solvent-refined coal demonstration plant and early development of eastern gas shales, which may be competitive by 1985 if prices rise.

Fri said that other major shifts of emphasis may follow in fiscal 1979, when the results are known from a current study on the effects of carbon dioxide on climate. Some scientists fear that CO_2 buildup would increase the "greenhouse effect" of the atmosphere, heating the earth and even perhaps melting the polar ice caps. Since increased coal burning would result in more generation of CO_2 , this study may bring about a decision to limit the expansion of coal-fired plants. Fri says this "could be to fossil fuel what proliferation was to the breeder." □

Sexes equal in alcohol, drug use

In a scene from the new Norman Lear sitcom, "All That Glitters," the harried female executive tries to relax with a scotch and water while her male secretary gazes lovingly at her, hoping she'll ask for a date. Role transformations may not have reached that stage in real life, but it appears as though at least the alcohol aspect is close to reality.

The results of a survey of nearly 2,000 high school students in central New Jersey indicate that females may have finally caught up to males in alcohol and drug use. But according to the survey, few of the youngsters consume excessively. Researchers at Rutgers University's Center of Alcohol Studies, who conducted the study, attribute much of the "catch up" phenomenon to the movement toward equalizing male-female roles. And the trend among adults appears to be mirrored in high school youths, says Rutgers's Robert Pandina, the study's principal investigator. "There are less constraints on