

Invariance Theory Upset

The positive and negative decay particles emerging from eta mesons leave bubble tracks that prove they do not behave identically—By Ann Ewing

See Front Cover

► THE LONG-HELD theory of physics that particles and antiparticles are mirror images of each other has been disproved.

In showing that this theory does not always hold true, scientists have discovered a way to tell absolutely whether a particle or an object anywhere in the universe is positively or negatively charged.

The overthrow of the so-called "invariance" of oppositely charged particles is the third upset to conservation laws in less than 10 years.

Physicists at Columbia University and the State University of New York at Stony Brook found that in the decay of the neutral particle known as the eta meson, the positive particle that emerges is more energetic and travels away from the reaction site faster than the emerging negative particle. This means that oppositely charged particles

in interactions of intermediate strength react in different ways, not in the same way as had previously been thought.

The overthrow of the charge invariance principle resulted from an experiment carried out at Columbia's Nevis Laboratories at Irvington-on-Hudson, N.Y., and at Stony Brook. Details of the experiment were reported in *Physical Review Letters*, 16:1224, 1966.

The discovery has been hailed as a milestone in science bearing on the fundamental nature of matter from the nuclear to the cosmic world, since positive and negative charges are the prime factors in all electrical, magnetic, chemical and atomic reactions and interactions.

Directing the experiment was the leader of the Columbia group, Dr. Paolo Franzini, whose wife, Dr. Juliet Lee-Franzini, headed the group at Stony Brook. Financial support for the test came from the U.S. Atomic Energy Commission and also the New York State Research Foundation.

Prior to the new results, the theory was that oppositely charged particles were mirror images of each other. This theory, known as "charge conjugation invariance," held on steadfastly for decades until two years ago when Dr. Val Fitch of Princeton University and his co-workers observed a violation of the so-called CP invariance, a conservation law intimately connected with the principle of charge conjugation.

The 1964 experiments showed that time is sometimes a one-way street—it has only one direction of flow under certain circumstances. This discovery made the situation with respect to time the same as it was previously for parity.

In 1957, scientists discovered that nature makes a distinction between left-handed and right-handed in the jumbled world of particles within the atomic nucleus. This is a distinction in space, which had previously been thought symmetrical.

Now it is known that in addition to parity and time, charge is not symmetrical under all circumstances.

Following the 1964 overthrow of the time symmetry, Dr. Tsung-Dao Lee of Columbia, co-winner with Dr. C. N. Yang of Princeton University of the 1957 Nobel Prize in Physics for suggesting a test for the nonconservation of the parity principle, developed a theory to explain the violation of the symmetry of time. Others developed theories to deal with the same problem. Dr. Fitch had observed invariance violation only for the so-called weak interactions. For stronger forces in nature, the invariance principle was presumed to be preeminent. Now it, too, has fallen with the discovery that charge conjugation does not always hold true.

In the experiment, the Drs. Franzini, and Dr. Charles Baltay and Dr. Lawrence Kirsch of Columbia, with five other physicists, analyzed 1,441 instances of the decay of the eta meson into three kinds of pi mesons, or pions, one with a positive charge, one with a negative charge and one neutral.

They found that the positive pi meson traveled away from the completely disintegrated eta meson at a greater velocity than the negative pi meson.

Some 435,000 photographs, showing various decay patterns of the eta meson, were taken in the 30-inch Columbia-Brookhaven bubble chamber.

In the Columbia University photograph shown on the cover, tracks are seen at the left of positive pions, which travel in many numbers from bottom to top. The key reactions are illustrated in the drawing on the right.

When a positive pion hits a deuteron, it interacts to produce two protons (dark tracks resembling an arrowhead) and a neutral eta meson. The invisible eta meson disintegrates virtually instantaneously into a neutral pion, also invisible, and a positive and negative pion, which are seen as tracks diverging from the arrowhead vertex. These decay products, particle and antiparticle, were the ones observed to be asymmetric.

• *Science News*, 90:18 July 9, 1966

**THIS KIND
OF CLOCK TELLS
A DIFFERENT
KIND OF TIME.**



It even glows in the dark... like a Princess phone.

Time is just time you say? Well read how this Caslon Clock will change the way you read it.

It is a psychological fact (try it on friends) that when people look away from an ordinary clock (one with hands!), they seldom remember the exact time. They know about what time it is. This is because most often you just glance at a clock to orient yourself to the time . . . in relationship to some upcoming moment, date, event or whatever. But. When you glance away from this digital timepiece and someone asks you the time: you'll give it exactly. Right to the minute. "It is 3:43". That's the difference between seeing all 12 hours at once and this "digital readout" that states the precise time, and only the precise time.

The numbers of this plug-in electric clock can be read at a good 50-paces. A silent electric motor flips the plastic plates into view faster than the eye can see. One second it's 3:43 and then, suddenly, it's 3:44. Don't worry. The change is silent. Not even a "click".

This improved way of telling time is the 110V Caslon 201 digital electric table clock. If that sounds like a mouthful you should see it in 3-dimensional color. It's an eye-ful. Beautiful, in the modern manner. The console shape is at home with any decor, in any room — or office. You have a choice of four colors (see cou-

pon) to complement your furnishings. But most important, the Caslon 201 tells time in a way you can't mistake — won't forget! It is something of a conversation piece, too. People will stand there staring at it, waiting, trying to catch it changing time. But it is faster than a wink, and quieter than your wristwatch. (The precision synchronous motor is of the hysteresis type — with 18 poles — operating at a low speed to assure even, silent operation and a good long life.)

P.S. The Caslon makes a beautiful gift — the kind you would love to receive.

TAKE TIME - ORDER NOW

Mail to: **HAVERHILL'S**
526 Washington St., San Francisco, Calif. 94104
Please mail me the 110V Caslon 201 digital electric table clock.
 I enclose \$24.90 plus \$1.00 for Post. & Ins. Satisfaction or refund guaranteed.
(California Residents Add 4% Sales Tax)
 Diner's Am. Expr. Acct. # _____
Underline your choice of color: (1st and 2nd)
Red-Red Airline Blue Wheatglø Deep-Night

Name _____
Address _____

© 1966 SN-0709 **Haverhill's**
Searching the World to bring you the Finest