



## Dr. Chien-Shiung Wu— Changing the World of Physics

Activity

35

A brilliant young woman arrived to study in a new country. Two decades later her work had turned the world of physics on its head. That young woman was the famous experimental physicist, Dr. Chien-Shiung Wu. She is most remembered for her influential experiments in nuclear beta decay.

### The Science of the Atom

Ancient alchemists dreamed of turning one chemical element into another, thus producing gold from less valuable elements. But as atomic theory developed, their dream was shattered. Scientific observation revealed that an atom was a stable, indivisible unit of matter. Scientists believed that an atom could not change into something else.

The study of radioactivity in the early 1900s, however, brought about the realization that atoms do change during nuclear events. For example, the nuclei of uranium and some other elements are unstable. They gradually decay, or break apart into the nuclei of elements with smaller atomic masses. Such a process is a change in the chemical nature of the element itself. Marie and Pierre Curie gave this decay the name radioactivity.

As nuclei decay, they release particles and rays called radiation. Radiation consists of alpha particles, beta particles, and gamma rays. Alpha particles are positively charged nuclear particles made up of two protons bound to two neutrons. Beta particles are either electrons or positive particles that are equivalent to electrons and are known as positrons. Gamma rays are electromagnetic rays. Wu's lifetime of study was based on beta decay, the emission of electrons from radioactive nuclei.

### Wu's Early Career

Wu, spent most of her career studying nuclear forces and structure. She was born in Liu Ho, China, in 1912. She studied physics at the National Central University in Nanking in the 1930s, graduating in 1936.



Physicist Dr. Chien-Shiung Wu

At that time, China was fighting a war against Japan. After earning her degree, Wu decided to emigrate to the United States. Once arriving there, she began studying at the University of California at Berkeley.

When Wu had finished her doctorate, she taught at Smith College and later at Princeton University. Then, in 1944, the Division of War Research at Columbia University in New York City hired her to work on the detection of radiation. Her new job gave her a chance to study the process of radioactive decay.

### Challenging the Law of Parity

At Columbia University, Wu became well known for her experimental work in nuclear beta decay. Meanwhile, two scientists working with her, Dr. Tsung Dao Lee of Columbia and Dr. Chen Ning Yang of Princeton University, were already noted for their work in quantum theory physics.

One of the laws of quantum theory is the law of parity, a basic law of physics that compares

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the behavior of a subatomic particle with that of its mirror image. Basically, the law of parity holds that some objects are the mirror images of other objects. This would mean that the same basic principles that apply to one object would have to apply as well (in every detail) to an object that was its mirror image.

### Wu's Famous Experiments

Up until this time, scientists had assumed that nuclear decay obeyed the law of parity. Lee and Yang, however, pointed out that the parity law had never been proven in nuclear reactions. To find out whether such reactions obeyed or broke the law, they asked Wu to perform some experiments. Although her experiments later won Wu great praise, Lee and Yang first doubted her results. Wu focused her work on the decay of cobalt-60, a radioactive form of the element cobalt. When cobalt-60 decays, it produces intense gamma radiation.

Wu wanted to examine the beta particles that were released during this process in order to see whether they obeyed the laws of parity. She performed the experiment in a cryogenics lab, where the cold temperatures required for the observation were possible. She then placed the cobalt-60 in a strong magnetic field and aligned the north and south magnetic poles in the atoms. Finally, Wu supercooled the nuclei and carefully watched

the movement of the electrons emitted by the decaying nuclei. The electrons moved primarily in one direction. If the parity theory were true with nuclear reactions, the electrons would have moved from both the left and right sides in a symmetrical way. Her observations shattered this law of quantum theory. A few days later, fellow researchers at Columbia duplicated her results. Today, most scientists agree that this seems to be the case for all subatomic particles.

### A Lifetime of Achievement

Wu's experiments confirmed her colleagues' hypothesis. In 1957, Lee and Young won the Nobel Prize for Physics. Although Wu did not win a share in the Nobel Prize, news about the experiments gave her world-wide attention. For her contributions, she was awarded the Research Corporation Award. Wu was elected to the National Academy of Sciences in 1958. Afterward, she continued to prove herself to be a tireless researcher. She continued her studies of nuclear beta decay, and in 1963 produced more evidence against the law of parity. In 1978, she became the first woman to receive the Wolfe Prize, as well as the first living scientist to have an asteroid named after her. These are just a few of the awards from a long list of those she received. Wu retired from Columbia in 1980 and died in 1997.

### Active Reading

1. What did Wu's famous experiments reveal?
2. Do you think that Wu should have shared in the Nobel Prize for Physics? Why or why not?
3. What caused Lee and Yang to question the law of parity? Why is it important to test theories in many different situations?

### Alternate Assessment

Radiation cannot be seen, heard, or felt, but it can be detected. Find out how electroscopes, cloud chambers, bubble chambers, nuclear emulsions, and Geiger counters are used to detect radiation. Make a chart that explains how each device indicates the presence of radiation.