KEK 1m Hydrogen Bubble Chamber（1977-1980）

The bubble chamber is a kind of device for elementary particle experiments. In the chamber, liquid hydrogen is filled in a container that can sufficiently withstand pressure from the inside. When a beam (incident charged particles:protons or mesons) enters and interacts with hydrogen nuclei, particle generation and annihilation reactions occur. Micro bubbles are generated in a streak pattern along the flight path of the generated particles. By shooting at the same time, you can capture the track in three dimensions. By examining the film taken at this time in detail, you can study particle reactions.

Donald Arthur Glaser (USA)
（http://www.nobelprize.org/）

KEK 1m Liquid Hydrogen Bubble Chamber

Operating principle

The liquid will boil above a certain temperature called the boiling point, but the boiling point depends on the pressure. It is well known that hot water boils at low temperatures when climbing high mountains. This is due to the low pressure in high-altitude areas. Using this principle by suddenly reducing the pressure (without changing the temperature significantly), you can quickly create an environment where the liquid boils. However, even if sudden boiling conditions are met, it often does not become a gas immediately. In this case, the liquid wants to become a gas, but it cannot do it without any stimulus.

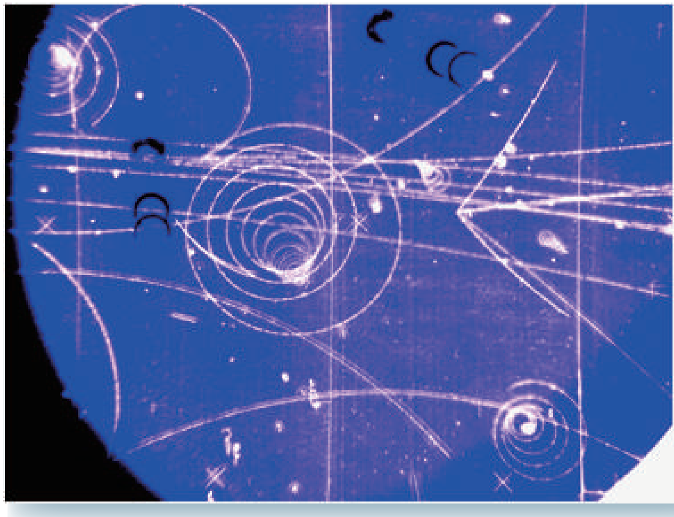
The hydrogen bubble chamber (it is better to say “pot” rather than “chamber”) is filled with liquid hydrogen that has been cooled to a low temperature. This “pot” has a piston so that the internal volume can be changed, and it can be pulled quickly to reduce the internal pressure. This realizes an environment where liquid hydrogen boils. When a particle beam is injected into the bubble chamber in accordance with the timing of this pressure drop, it ionizes hydrogen atoms and the generation of these ions stimulates fine bubbles (boiling into gas). A large number of bunches of hydrogen are streaked. If you observe this situation a little further away, you can see the trajectory through which the particles have passed. This is the principle of bubble chambers. In 1952, Glaser (left photo) devised this mechanism and won the 1960 Nobel Prize in Physics for his work.

The upper photo (right photo) is a bubble chamber that was once constructed at KEK, and its diameter is about 1m. During the experiment, a strong magnetic field is applied to the entire bubble chamber. When a charged particle runs in a magnetic field, the bending is reversed depending on whether the charge is positive or negative, so you can see if the charge is positive or negative, and you can also know the momentum of the particle from the radius of the bending. This device, which was active at KEK, is now on the 3rd basement floor of the National Museum of Nature and Science, Tokyo Ueno.

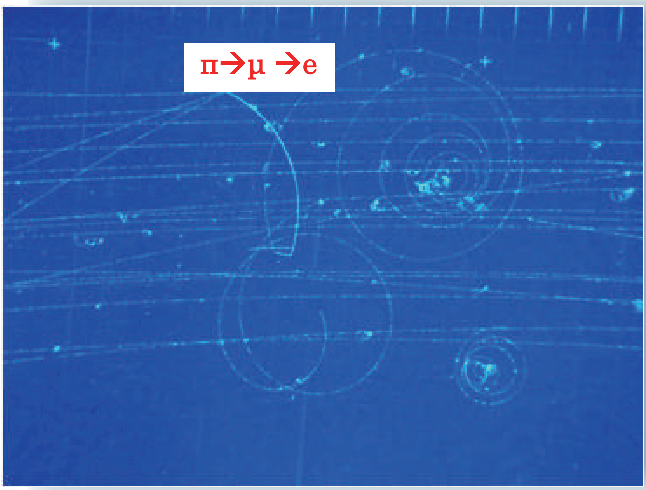
The world of elementary particle reaction in photos

KEK 1 m Bubble Chamber Examples of particle generation events

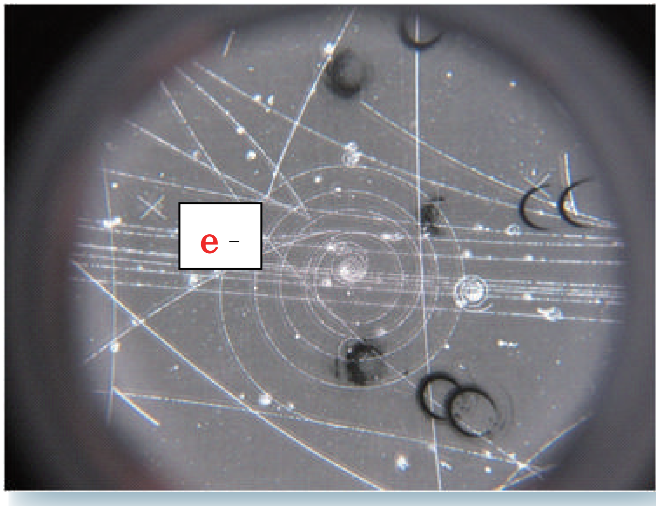
Multiple production and $\pi \rightarrow \mu \rightarrow$e decay chain



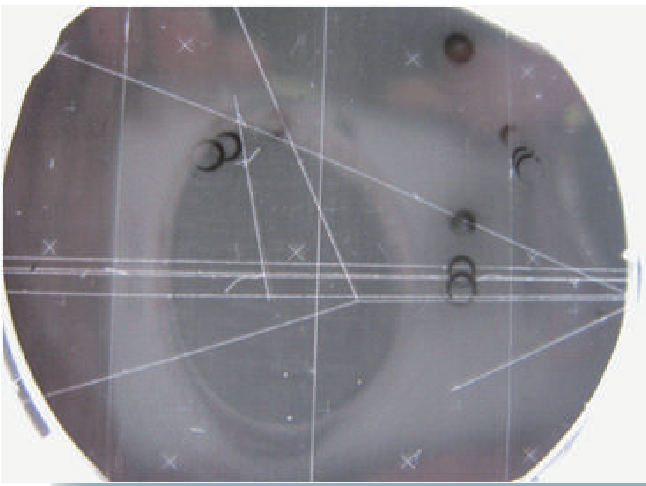
Decay of A neutral particle and creation of particles



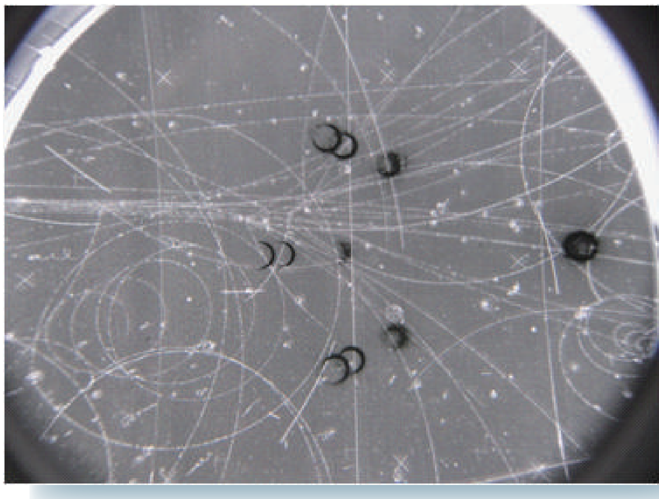
A decay chain



δ-ray (Launching electrons outside of the nucleus)
The center circle is the track of electrons



When there is no magnetic field, the tracks become straight lines



Hundred Flowers