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Nobel Prize in Physics 1960

Donald Arthur Glaser

The Nobel Prize in Physics 1960 was awarded to Donald A. Glaser *"for the invention of the bubble chamber"*.

RESEARCH INFORMATION:

Surely we all have often admired the beautiful white streaks which are left against the blue heaven by a highflying jet airplane. These streaks are made up of very small, finely divided waterdrops which have been condensed into a cloud track behind the plane. Long after the plane has vanished in the distance, one may in detail, with the help of these cloud tracks, trace every movement made by the plane. A similar visual method is utilized in nuclear physics in order to expose the passing of individual atomic particles through a gas. It is the famous "cloud chamber" which has played such an important role in nuclear physics and which provided its English inventor, C.T.R. Wilson, the Nobel Prize in Physics 33 years ago, that is, 1927. There prevails a certain connection between the invention which is today awarded this prize and Wilson's invention; we therefore have reason to remind ourselves of the Wilson chamber's method of function: An atomic particle, such as one from a radioactive material, produces along its path charged fragments which are called ions. If the atomic particle is made to pass through a gas chamber which contains a supersaturation of water vapor, the ions will function as centers of condensation, and small water-droplets are formed along the particle's path, just as in the case of the jet-planes' vapor streak. The supersaturation of water vapor was brought about at a suitable chosen instant by allowing the gas in the chamber to rapidly expand with the help of a mobile piston in the chamber's base. If simultaneously there is a light flash illuminating the gas in the chamber, the fine cloud-track formed by the chamber's expansion after the particle's passage can be photographed. One may photograph such processes as atomic decay, nuclear fission, and cosmic rays, just to mention a few examples. It is truly a wonderful invention, especially if one considers the fact that the atomic particles which are made visible in this refined manner are no larger than one-hundredth of a billionth of a millimeter.

The Wilson chamber has certainly played a tremendously important role, especially during the 30's, which is referred to as "the golden age of nuclear physics", and there is no doubt that it was the Wilson chamber which made possible the greatest nuclear physical discoveries during that decade. It was also an ideal research instrument for that time, because the nuclear particles which were then of interest, and which were possible to depict by artificial means twenty to thirty years ago, had ranges which, for the most part, are of the order of several decimeters in a gas at normal pressure. In other words, particles had energies of some million volts and there was no difficulty in using the Wilson chambers, which were sufficiently large, in order to be able to photograph paths of all incoming particles along its entire length as well as all of the possible nuclear reactions which would have enough room to occur within the Wilson chamber.

The situation is completely different in the nuclear physics of today, where one now has at one's disposal particle accelerators with energies as high as 25 billion volts, for example the accelerator which has recently been built at the European nuclear research center in Geneva. In other words, energies which are more than 1,000 times larger than those which were earlier obtainable. In order to be able to register such particles during the entire time of flight interval, one would be forced to use a Wilson chamber of the

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inconceivable size of 100 meters or more. It is obviously necessary to use a medium other than gas in order to be able to bring such particles to rest. Donald Glaser has succeeded in solving this problem, and his so-called "bubble chamber" is the *high-energy nuclear physics* counterpart to the *lowenergy nuclear physics* Wilson chamber. As you will remember, it was last year that the discovery of the so-called "antiparticles" was rewarded with the Nobel Prize. An anti-particle is the "inversion" of a particle, its "mirror image". One could say that Glaser's bubble chamber is an anti-Wilson chamber. Particle tracks in Glaser's chamber are composed of *small gas bubbles in a liquid*.

We depart from this and the jet plane now, and turn our attention instead to something as prosaic as what happens when one opens a soda-water bottle. In this manner we follow with all sureness Donald Glaser's own train of thought from the moment he received his first impulse toward his invention of the bubble chamber. If we ease up on the pressure in the bottle by removing the cap, bubbles will rise from the liquid. The bubbles come preferably from certain points which serve as centers for bubble development. Glaser's next step in his line of reasoning was to use, instead of a soda-water bottle, a liquid which is heated to a temperature near its boiling point and which is enclosed in a chamber. If the pressure is rapidly eased from above the liquid, for example by use of a mobile piston, the liquid will have a tendency to boil. With a certain amount of care, one is able to maintain the liquid in this superheated, unstable state without boiling. The slightest disturbance in the liquid, however, gives rise to an instantaneous boiling, exactly as did the opening of a soda-water bottle. Glaser's idea was that an atomic particle passing through the liquid would be able to provoke boiling by means of the ions which the atomic particle produces along its path and which act as bubble-development centers. If a flash picture were subsequently taken of the superheated liquid immediately after an atomic particle passes through, one ought to be able to observe the particle's path which is followed by the small bubbles which would have been produced. It is necessary, of course, that one proceeds quickly, for immediately afterwards, the bubble-track will have degenerated into a general boiling of the liquid. This was Glaser's sound idea and, working according to his

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plans in a systematic manner, he was successful in realizing the first radiation-sensitive bubble chamber in 1952. Even if the principle of Glaser's bubble chamber can be considered simple, it represents an exceedingly difficult development program requiring several years of work which lie behind the completed invention which will now be awarded this prize.

Rather soon after Glaser had published his ideas and the results of his first experiments, there were several persons who realized that something important would come of this. Several other scientists also left important contributions to the practical shaping of different types of bubble chambers, but Glaser is the one who made the really fundamental contributions. In order to get his apparatus to function, Glaser was forced to consider the physics of bubble formation both from theoretical and experimental points of view. As usual, it turned out that only a systematic procedure for studying the complete problem led to a solution.

The most striking feature of development during the most recent years is without doubt the increase in size of the bubble chamber. Glaser's first little glass-receptacle of some centimeters in size and filled with ordinary ether has successively grown to extraordinary voluminous proportions which represent the engineering-art's most exclusive subtleties. The largest chamber built to the present time is close to 2 m long, 0,5 m wide and deep, and contains liquid hydrogen which is condensed by a large cooling device providing temperatures in the vicinity of absolute zero. This largest liquid chamber is surrounded by a powerful electromagnet which is capable of bending the paths of the particles so that the faint bubble-tracks become slightly curved. In this way one is able to identify the unknown atomic particles when they, traveling very close to the speed of light, pass through the chamber. The large bubble chamber has also an extremely complicated automatic read-off and calculation apparatus which sends information from the tracks in the bubble chamber into a larger mathematical-computer, which, in turn, after a moment's thought, forwards from the world of atoms the news which the nuclear researcher so eagerly awaits. This part of the setup has received the characterization name of "Frankenstein".

By using Glaser's bubble chamber the modern nuclear researcher has at his disposal just the scientific instrument which is required in order to exploit the gigantic atomic accelerators which in recent years have been constructed in atomic research centers in the U.S.A., West Europe, and Russia. Large research teams are now at work investigating the strange, new particles which are formed, transformed, and annihilated when the beam from these machines is directed into the bubble chamber; how atomic nuclei are split, and how from the atomic fragments new particles are again generated to later change guise and finally be destroyed.

Dr. Glaser. Your invention of the "bubble chamber" has opened up a new world for nuclear science. We can now observe with our own eyes all the strange processes which occur when high-energy beams from BeV machines are directed into your chamber. Already a great amount of information has been obtained in this way and many important discoveries will no doubt follow in the near future by means of your method. It is unusual for a development in modern nuclear physics to be due to such a large extent to one single man.

On behalf of the Royal Academy of Sciences I congratulate you most heartily. May I now ask you to receive the Nobel Prize from the hands of His Majesty the King.

For more details please visit:

http://www.nobelprize.org/nobel_prizes/physics/laureates/1960/press.html