Importance of the Discovery of the Positron

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June 6, 2024

The existence of antiparticles was theorized by Paul Dirac in 1928 due to their implication by Einstein's theory of relativity [1]. No such particles were discovered until 1932 by Carl D. Anderson, who was awarded the 1936 Nobel prize for his discovery. A cloud chamber, similar to the kind used frequently today to visualize the path gamma rays take, was used to view the tracks left by cosmic rays. The scattered electrons recorded in the experiment produced tracks that curved due to the presence of a strong magnetic field. Tracks were also observed with an opposite curvature compared to the tracks left by electrons and were predicted to be the “positive electron” (Fig. 1). The curvature was also distinct from those left by protons as the smaller mass affected the acceleration and led to tighter curves. The predicted mass was significantly smaller than the proton, which lined up with the theorized mass of the antiparticle. It was briefly theorized that they were simply electrons traveling in reverse, which was quickly shut down by a test in which a sheet of lead was placed in the chamber. The lead reduced the energy of the particle which could help determine the direction it was traveling in. This evidence led to the prediction that the anti electron, dubbed the positron, was the cause of the anomalous tracks. This discovery called into question the current understanding of the particles comprising an atom. It was thought at the time that a neutron was simply a composite of an electron and a proton. If this were true, the creation of positrons would lead to anti protons, which were not seen during tests[2]. This also revealed a new interaction, annihilation events. The unique properties of the annihilation event of a positron and an electron were soon realized, and used to great extent. When the two particles meet, they annihilate and release two photons. The angle they are released at is roughly 180°, which provides an astonishingly accurate line of incidence if both are measured. This was spotted and exploited by Michael E. Phelps in 1973 with his creation of the PET scanner [4].

The most well known application of positrons are PET scans, which stands for positron emission tomography. This procedure is often used to create a high resolution image of various types of cancers, which metabolize glucose very quickly., This is exploited by using a radioactive tracer, which is most commonly fluorodeoxyglucose, that the body treats as glucose and feeds to the malignant tissue. This tracer emits positrons by the decay of a proton into a neutron, which releases a positron. Since positrons are the antiparticles of electrons they annihilate on contact, releasing two high energy photons in the gamma ray range. These are detected as they easily leave the body, and are turned into an image of the malignant tissue [3].

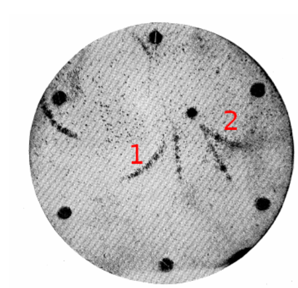

Fig.1 The path labeled 1 was left by an electron, and the path labeled path 2 was left by a positron, seen by the opposite curvature. The cause of the middle two tracks could not be determined. [2, Fig. 3]

[1] This Month in Physics History. August 1932: Discovery of the Positron. aps.org. American Physical Society. Web. 20 July 2024. <https://www.aps.org/archives/publications/apsnews/200408/history.cfm>

[2] Anderson, Carl D. The Positive Electron. Phys. Rev., 43, 491-494. (1933)

[3] Positron Emission Tomography (PET). hopkinsmedicine.org. Hopkins Medicine. Web. 20 July 2024. <https://www.hopkinsmedicine.org/health/treatment-tests-and-therapies/positron-emission-tomography-pet>

[4] Michael E. Phelps, 1998. science.osti.gov. U.S Department of Energy. Web 20 July 2024. <https://science.osti.gov/fermi/Award-Laureates/1990s/phelps>