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MISSING ENERGIES AT PAIR CREATION

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ABSTRACT

Wilson cloud chamber measurements of the separated spectra of positrons and electrons produced by gamma quanta of 6.14 MeV are differing drastically from the theoretically predicted (identical) spectra by BETHE and HEITLER, but are in good conformity to those of a modified theory of pair creation by one of the authors (B).

1. The experimental arrangement

A Wilson cloud chamber of the Blackett type (30 cm in diameter, 6 cm illuminated depth), filled with Helium at 1.2 bar gas pressure and a water alcohol mixture was operated to investigate pair creation by gammas of 6.14 ; 6.90 ; 7.11 and 8.87 MeV. These quanta will be emitted after irradiation of UREA (produced with highly enriched N15-nuclei) by the neutrons in the tangential hole of the 18 MW swimming pool reactor of the GKSS-Research-Centre Geesthacht near Hamburg. The cylindrical glass ring of the cloud chamber had a hole of 1 cm diameter, covered by a thin plexiglass foil to allow the gammas entering of the expansion room without passing the glass. Two Helmholtz coils produced inside the chamber a nearly homogeneous magnetic field of 703 Gauss (deviations from the homogeneity less than 1% within the illuminated volume). Helium was used to reduce the stopping power of the gas and also its motions due to its small expansion ratio (1.07 for $\kappa=1.67$). By this way positrons of energies above 30 KeV became measurable. But also below this limit pairs were still recognizable and could be distinguished from Compton electrons although the energies could not be determined precisely enough to present credible values.

The cloud chamber was installed at a distance of about 6 m from the reactor behind its 3.5 m concrete radiation shield. After an irradiation for at least one minute in the middle of the tangential hole a cartridge filled with 0.7 g UREA was transported within 3.2 sec to a lead bloc at the cloud chamber by a pressurised pipe line. A hole in the lead bloc "focussed" the gammas to a 25 μ m gold foil inside the chamber.(Fig.1)

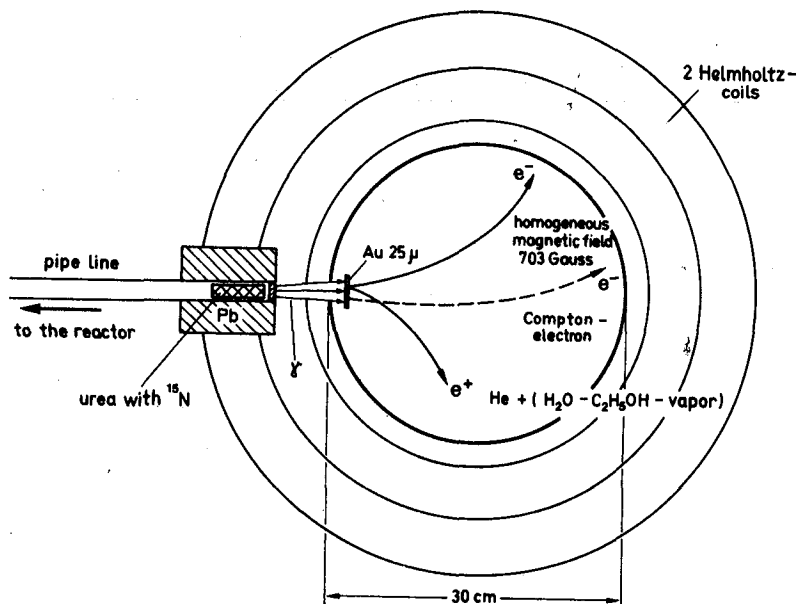


Figure 1. The Wilson cloud chamber arrangement with the Helmholtz coils, the pipe line for the cartridge transport and the 25 μ m gold foil as target for the pair production.

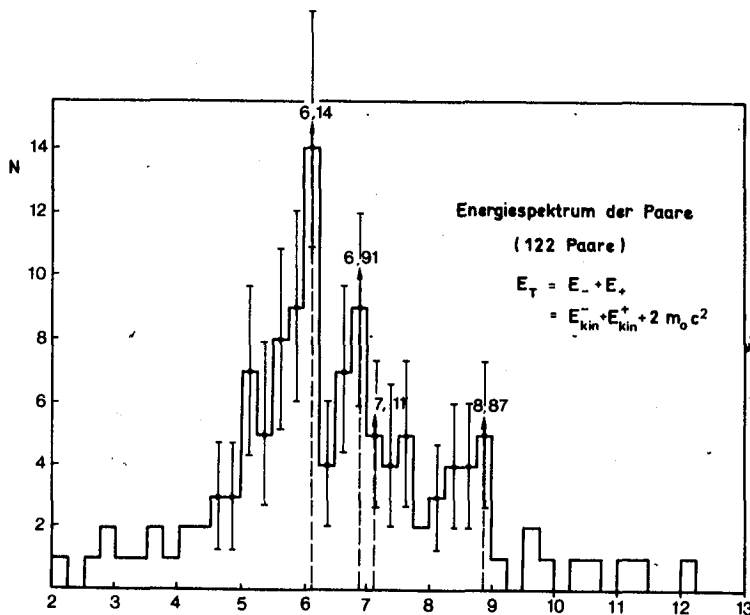


Figure 2. The energy sum spectrum of the positron-electron pairs produced by gamma quanta of 6.14; 6.90; 7.11 and 8.87 MeV. These quanta are emitted by ^{160}N -nuclei, generated by irradiation of ^{15}N -nuclei with the thermal neutrons of a swimming pool reactor and a subsequent β -decay of 7.13 sec lifetime.

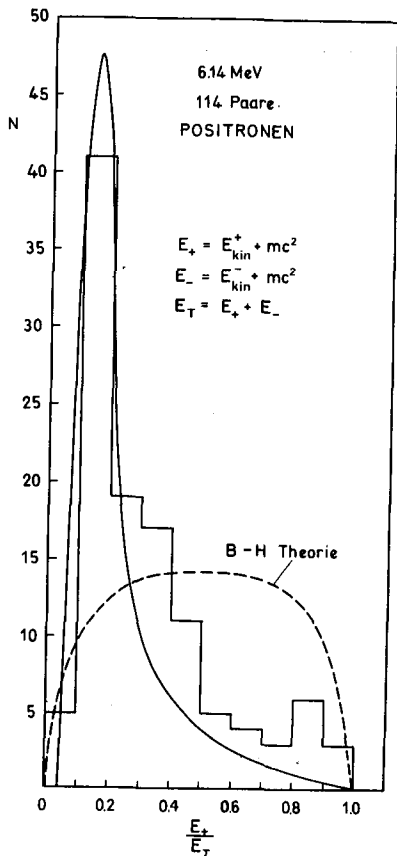


Figure 3.

The positron spectrum of 114 pairs created by 6.14 MeV quanta alone. Noteworthy is the high frequency of low kinetic energy positrons in full contradiction to BETHE and HEITLER's theoretically predicted (dotted) curve [2].

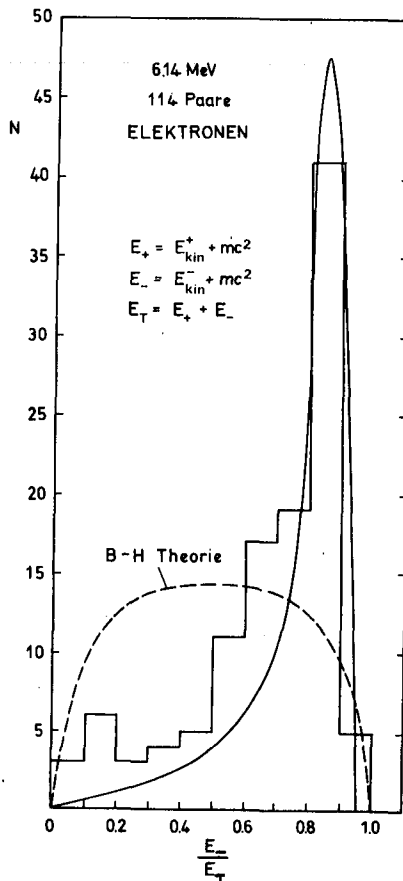


Figure 4

Here the corresponding electron spectrum of the same pairs as in figure 3 shows that these particles received mainly the highest possible energies at pair creation by the 6.14 MeV-quanta. There is no chance to say that positrons have identical spectra as BETHE and HEITLER's theory did it. The solid curves in the two figures 3 and 4 are derived in a modified theory of pair creation by BAGGE [3].