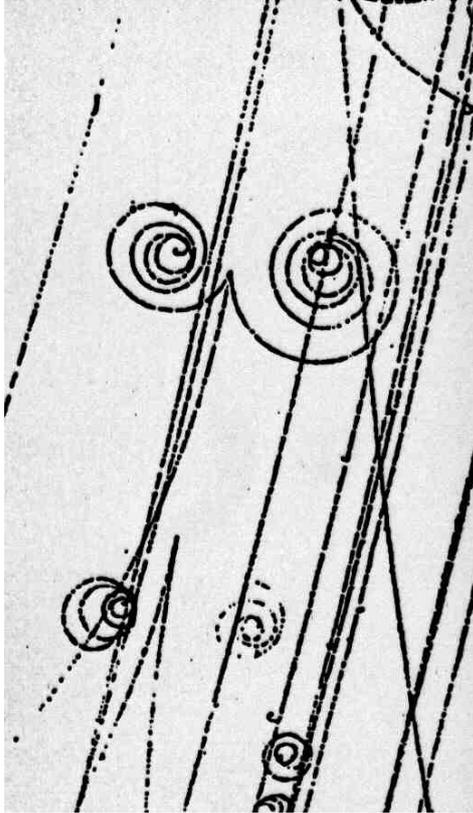
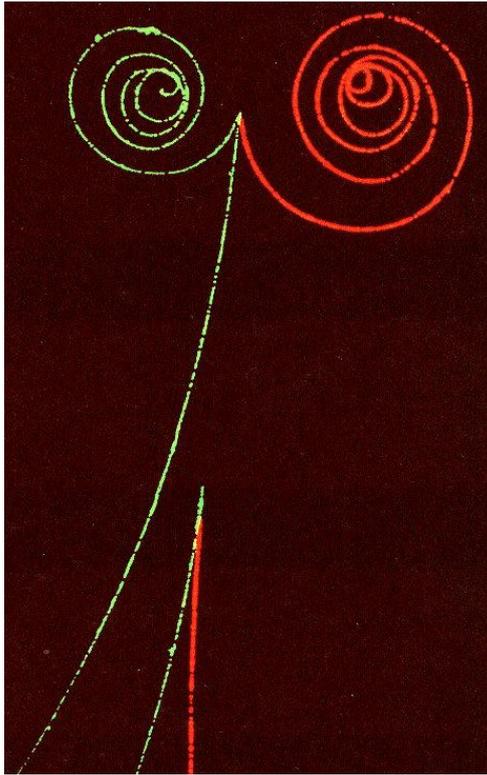


TAP 534- 3: Annihilation and pair production: bubble chamber pictures

Pair production: The original image



A processed image, with some tracks removed, and (below) the tracks coloured by curvature:



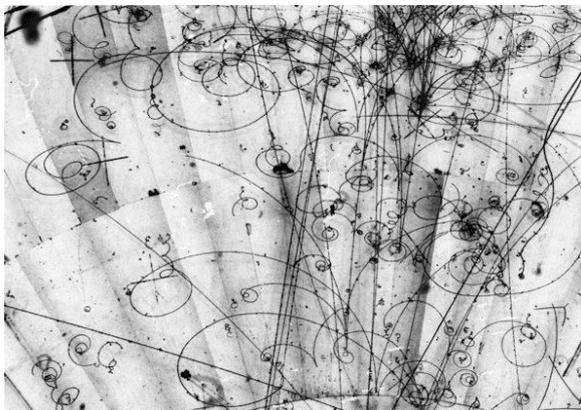
Both images can be interpreted by assuming two photons to be entering from the top of picture, leaving no track. One (top) has created a positron / electron pair and a 'knock on' electron from within an atom. The other has simply produced a positron / electron pair.

To think about:

- is there a minimum photon energy required to produce a positron / electron pair?

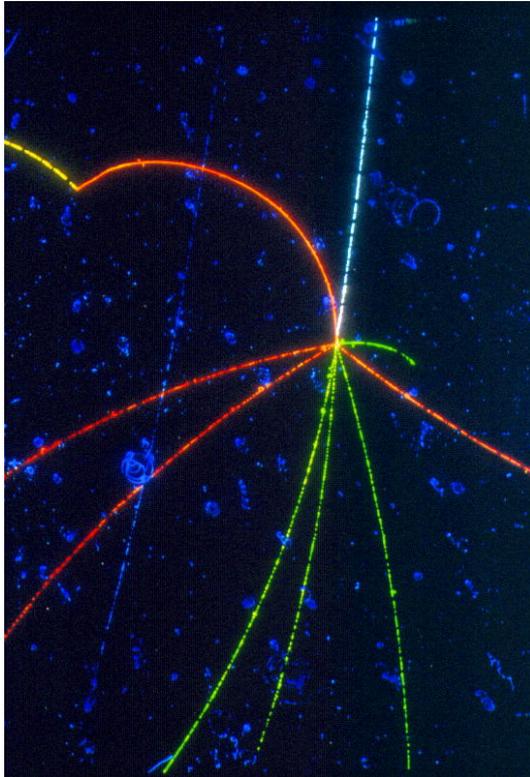
The pair produced in the lower event carry considerably more kinetic energy than the upper pair:

- what feature of the picture shows this?
- what is the physical reason for this?



This image above shows pair production of electrons and positrons as a stream of photons enters a bubble chamber. The photons leave no track, so that the particles appear to come from nowhere. How many of these events can you identify?

Proton–antiproton annihilation



Here an antiproton (coming in from the bottom left) strikes a proton. Mutual annihilation leads to four pairs of pions (π^+ and π^-). These curve in opposite directions in the magnetic field.

To think about:

- the antiproton is being deflected slightly to the right. In which plane is the magnetic field?
- can you identify the π^+ and π^- particle tracks?

Practical advice

These pictures may be used to illustrate annihilation and pair production. They might be printed out or made into OHP transparencies, with suitable captions. Use the questions as you see fit.

Answers and worked solutions

Pair production

The minimum photon energy required to produce a positron / electron pair is $2mc^2$.

The feature that shows higher speed is less curvature.

Initial photon had greater energy.

Proton–antiproton annihilation

The magnetic field is directed “into the page” (NB anti-proton has a negative charge)

The π^+ and π^- particle tracks are red and green respectively (the π^- will deflect the same way as the anti-proton)

External reference

This activity is taken from Advancing Physics chapter 17, display material 10S