Bubble Chamber Detective

Check this site out for more information about bubble chambers!

Altered from the original at
http://teachers.web.cern.ch/teachers/archiv/HST2005/bubble_chambers/BCwebsite/index.htm

Physicists learnt about hundreds of new particles by examining the trails they made in bubble chambers. This analysis uses a few rules;

1) The bubble chamber is filled with liquid hydrogen. The particles may hit the electrons or protons.

2) Trails are formed by hydrogen bubbles triggered by moving charged particles.

3) Charge is conserved. It is either +1 or –1.

4) A constant magnetic field causes circular motion.

5) Momentum is conserved.

The parallel lines show the paths of negative kaon particles injected into the chamber.

Which way are they traveling?

a) Up

b) Down

c) Not enough information

The interactions must be downstream.

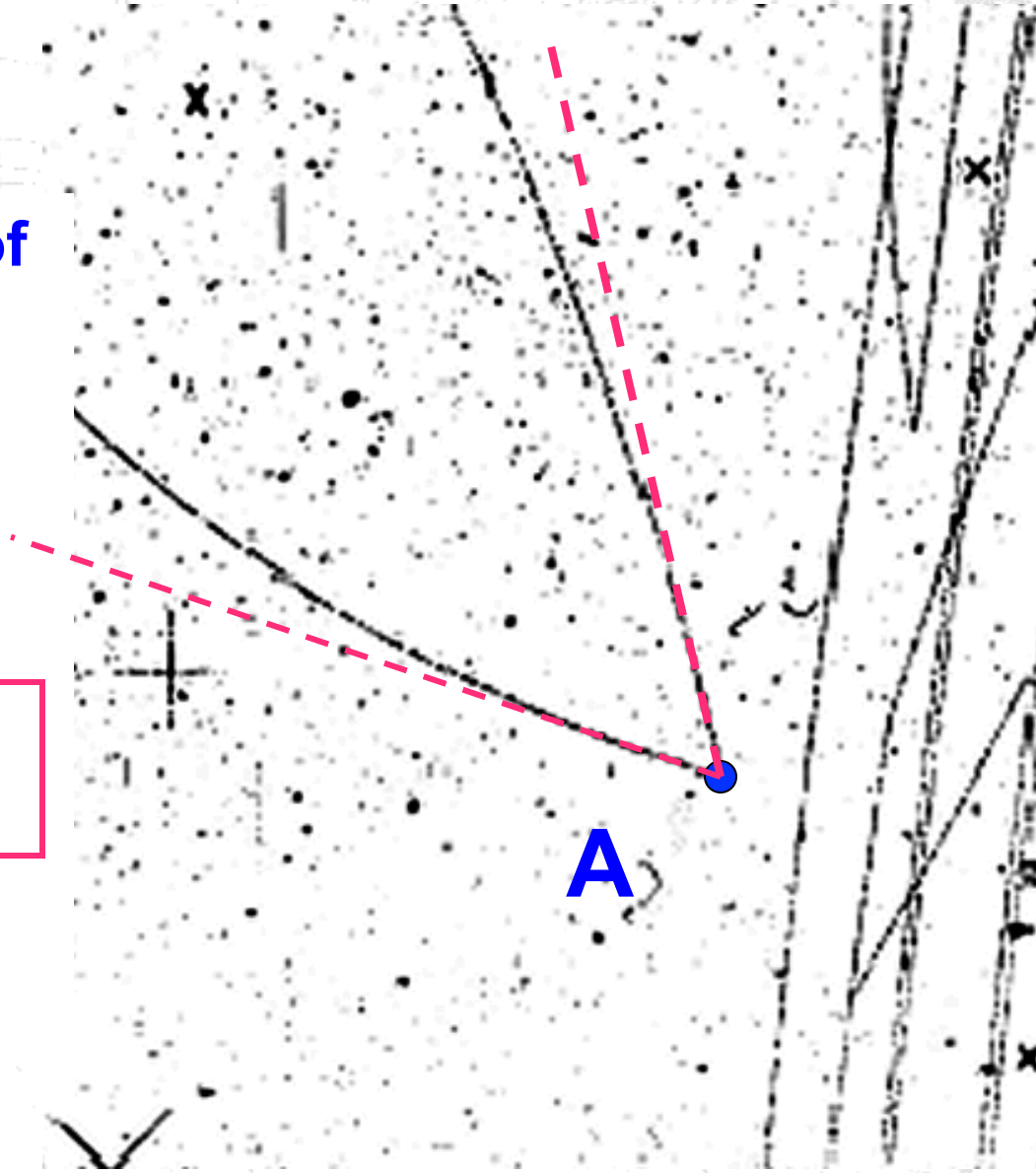
What are the charges of the particles that leave point A?

a) Two positive

b) Two negative

c) Positive on top and negative below

d) Negative on top and positive below



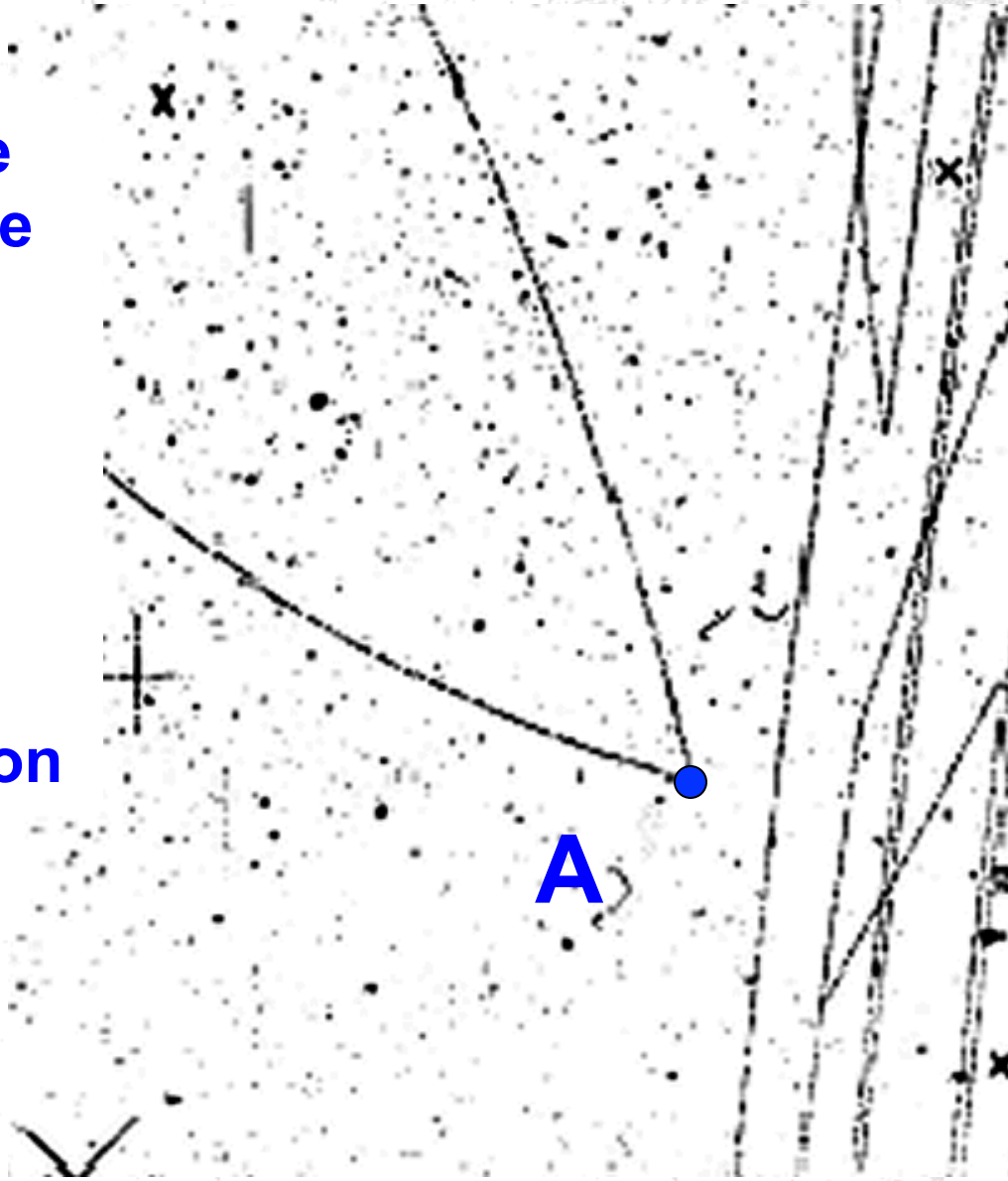
What is the charge of the particle that produces the event at point A?

a) Positive

b) Negative

c) Neutral

d) Not enough information



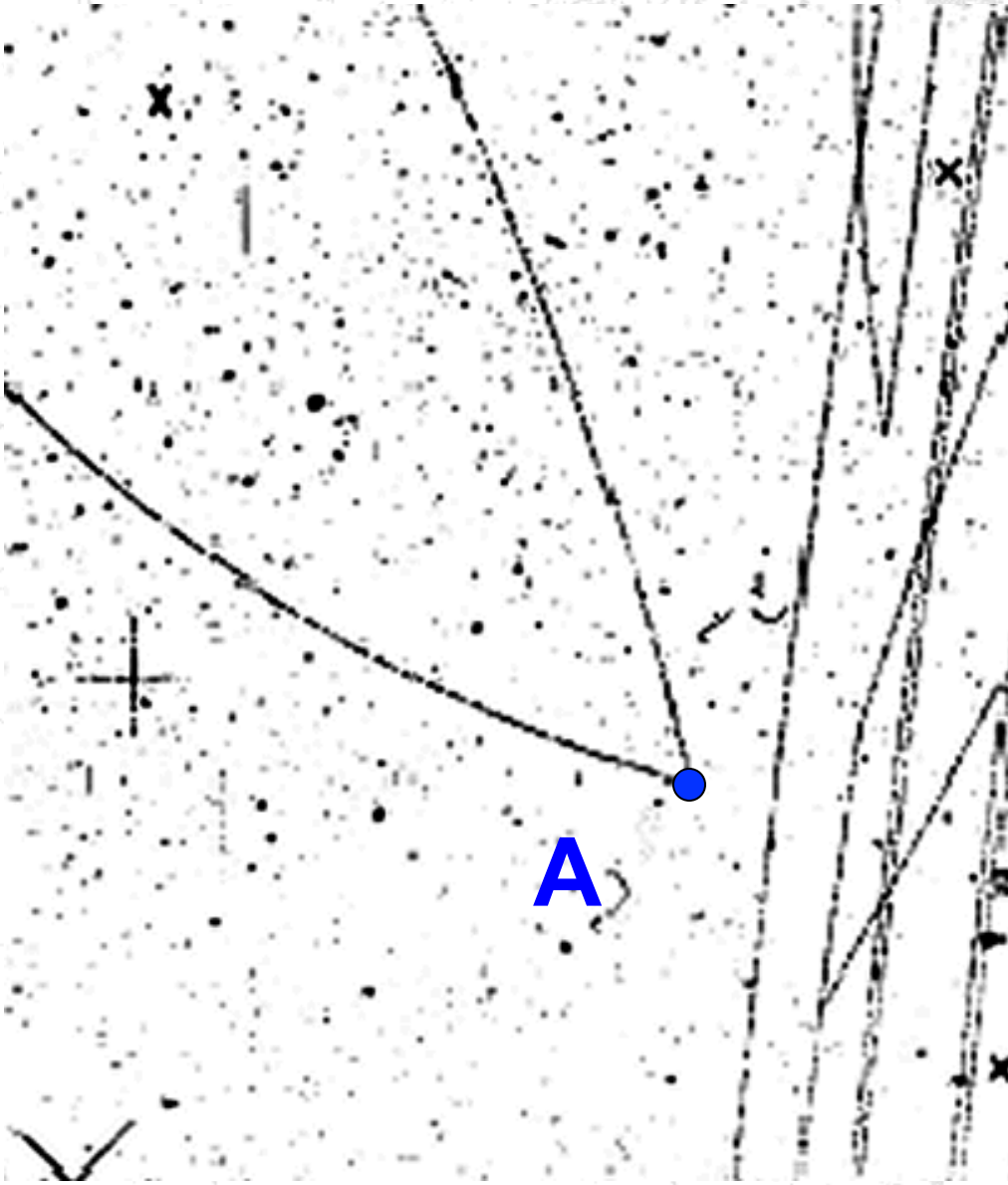
Charge is conserved.

Why don't we see the neutral particle heading toward point A?

a) Neutral particles don't cause bubbles

b) The particle wasn't moving

c) The particle was moving too fast



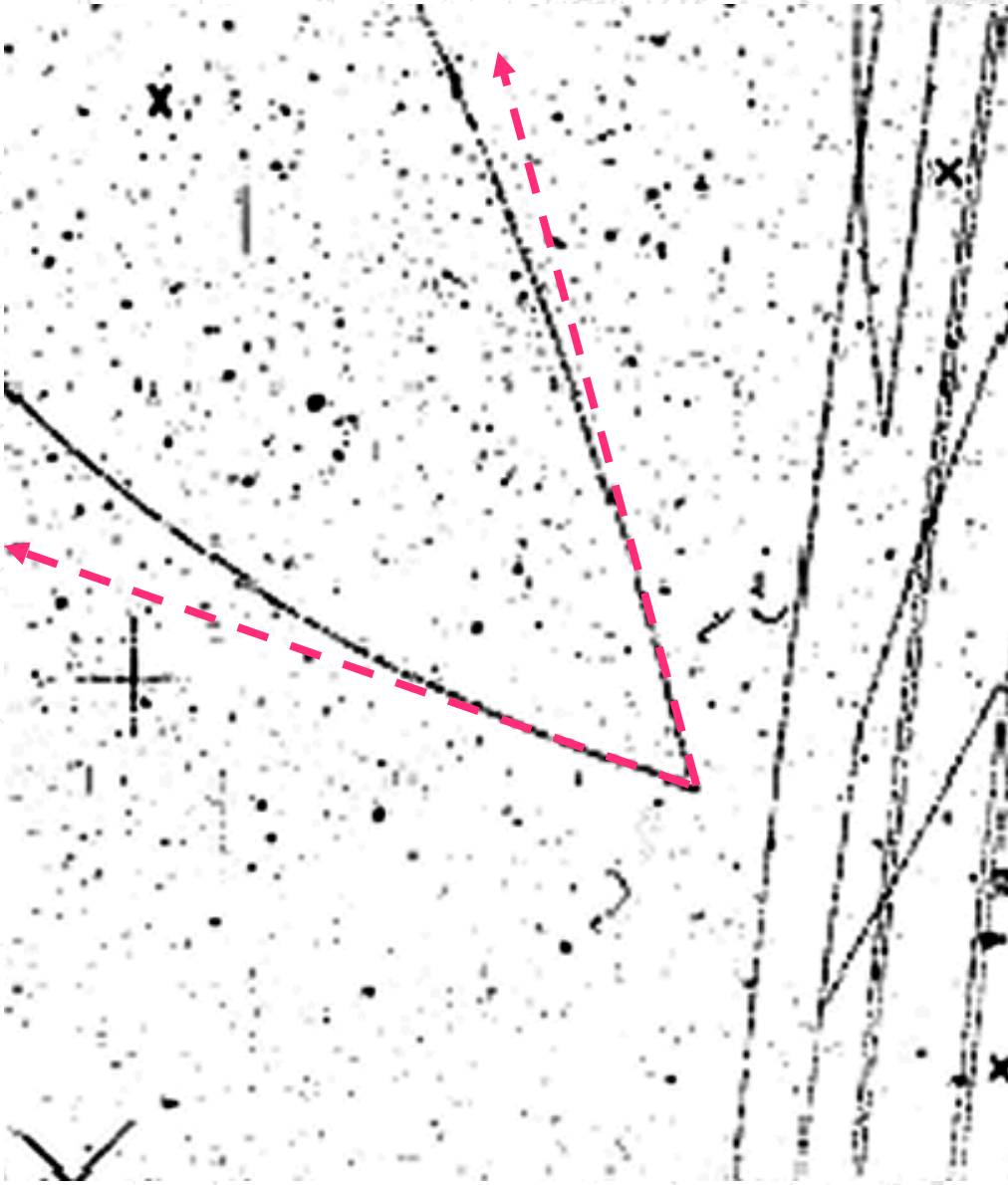
Which particle has more momentum?

a) Top one

b) Bottom one

c) The momenta are equal

d) Not enough information



In what direction was the neutral particle traveling before it decayed?

a) →

b) →

c) →

Momentum is conserved.

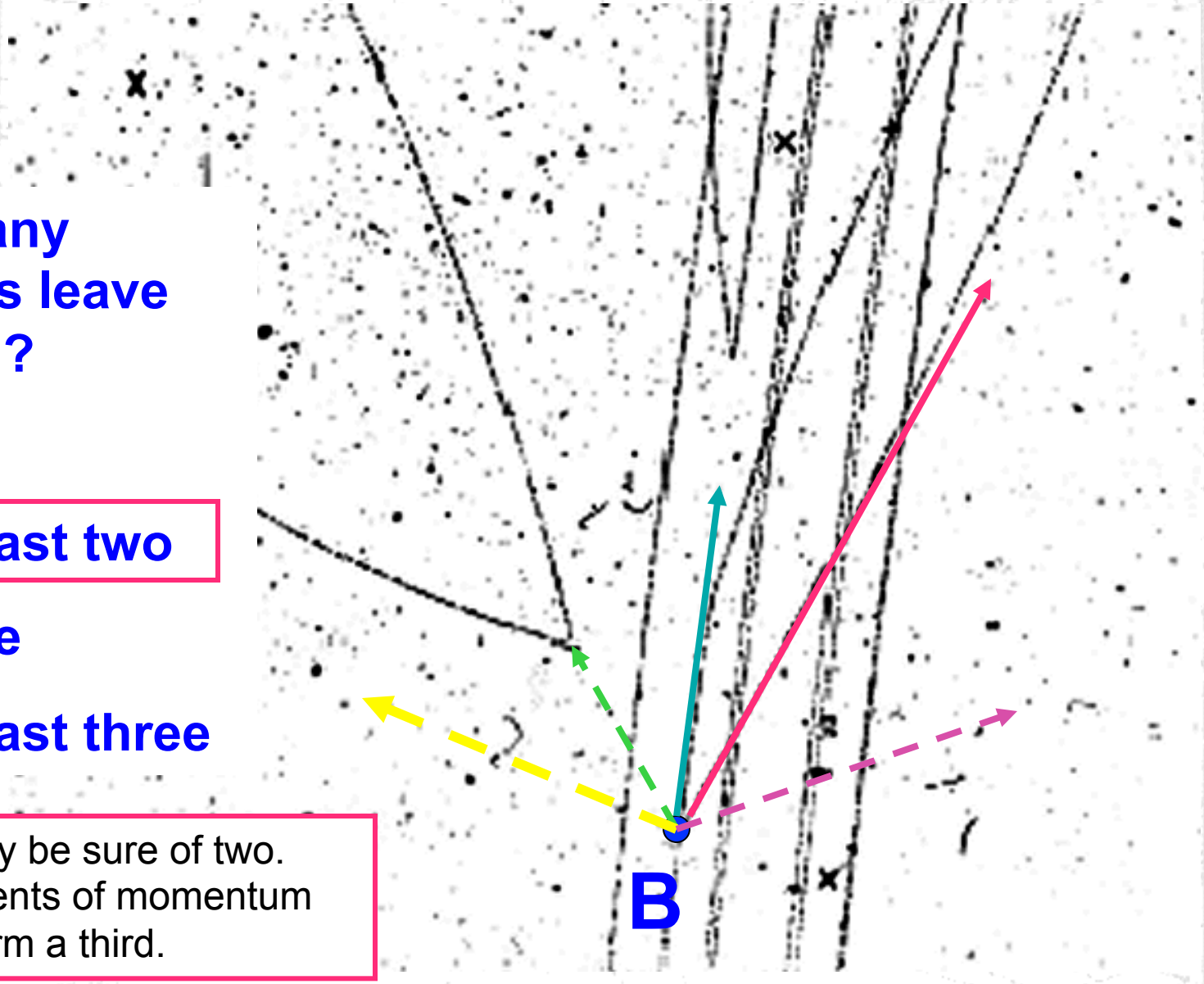
How many particles leave point B ?

a) Two

b) At least two

c) Three

d) At least three



We can only be sure of two. Measurements of momentum could confirm a third.

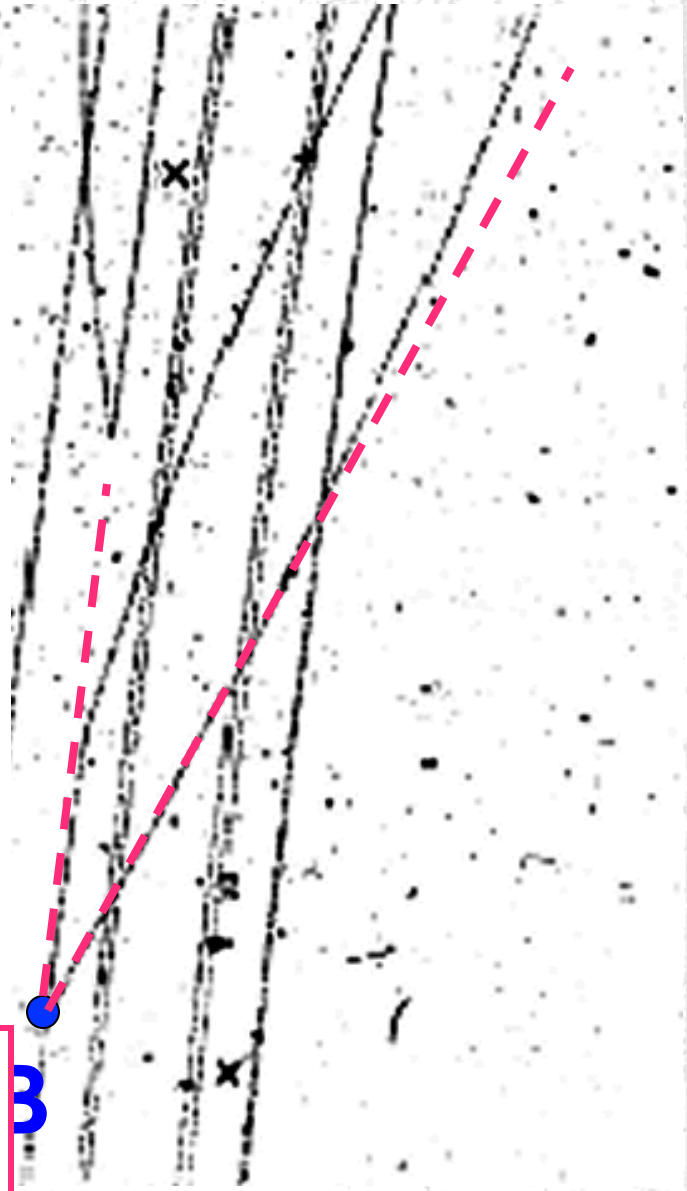
What are the charges of the two charged particles from B?

a) The right one is positive and the other is negative

b) The right one is negative and the other is positive

c) Both are negative

d) Both are positive



The right one curves left - it must be positive.

The other one's track is too short to see a curve, but it should be negative to conserve the kaon's charge.

How can a negative kaon produce a positive and a negative particle?

The negative kaon interacted with a positive particle. That particle was not visible because it

a) was not moving.

b) was moving too fast.

c) was moving into the page

The chamber is filled with hydrogen, a source of many protons that are not moving.

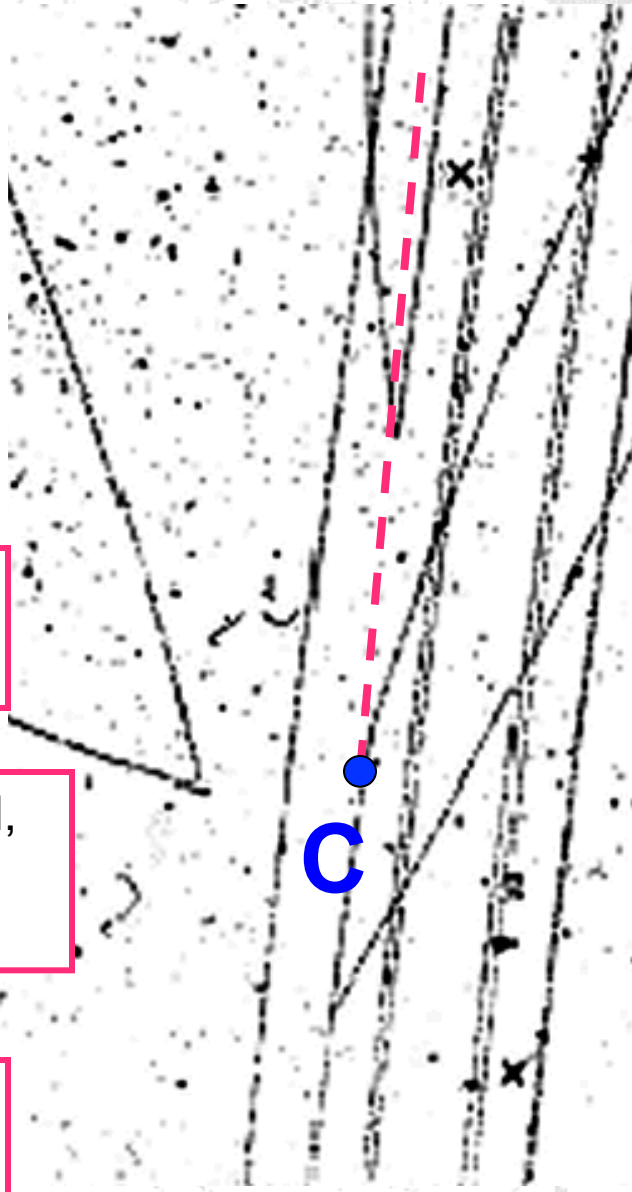
What happened at C?

The negative particle

a) collided with a neutral particle.

b) collided with a positive particle

c) decayed into a negative and a neutral particle



The momentum of the charged particle has changed, so there must be another particle to conserve momentum. It must be neutral to conserve charge.

The liquid hydrogen contains lots of electrons and protons but no neutral particles to collide with.

What happened at D?

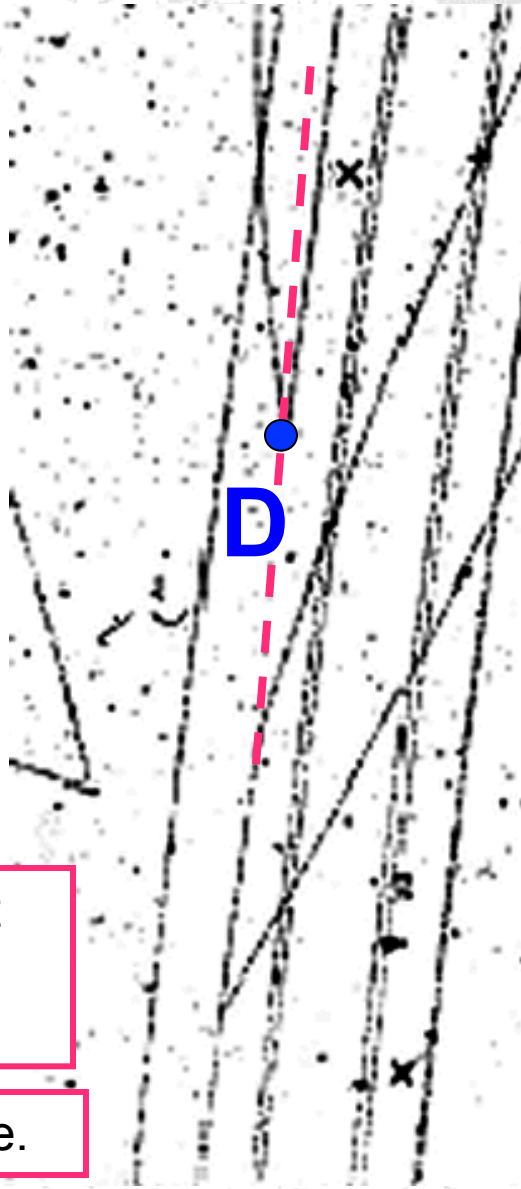
The neutral particle

a) collides with a neutral particle.

b) collides with a positive particle

c) decays into a positive and a negative particle

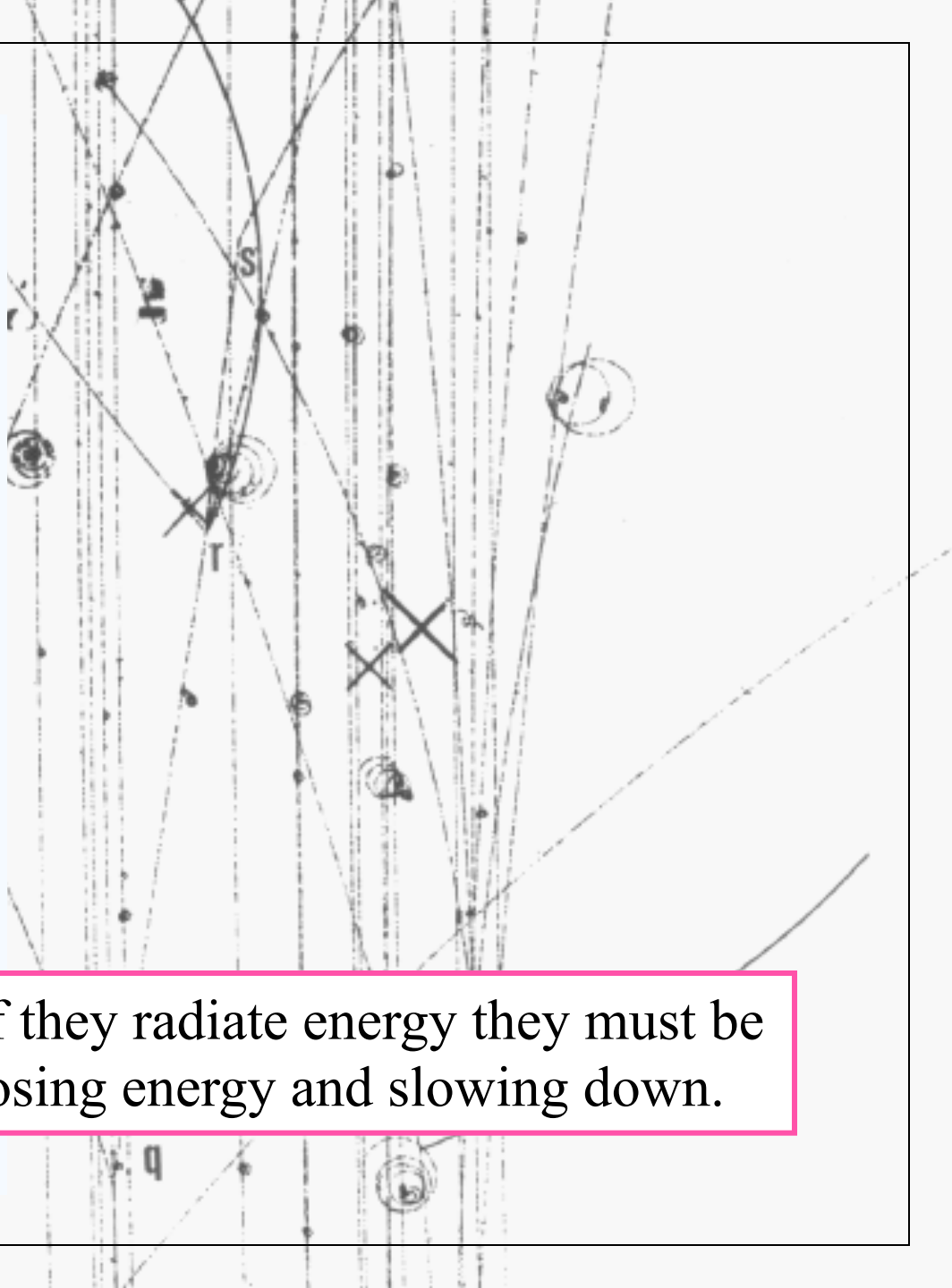
d) decays into two negative particles



The left particle is curving right, so it is negative. We can't see which way the right particle is curving but it must be positive to conserve charge.

The net charge after is neutral so it must be neutral before.

The liquid hydrogen does not contain neutral particles.



The lightest particles in these photos are the electrons. They will have the greatest acceleration and therefore will radiate energy fastest.

What will their paths look like?

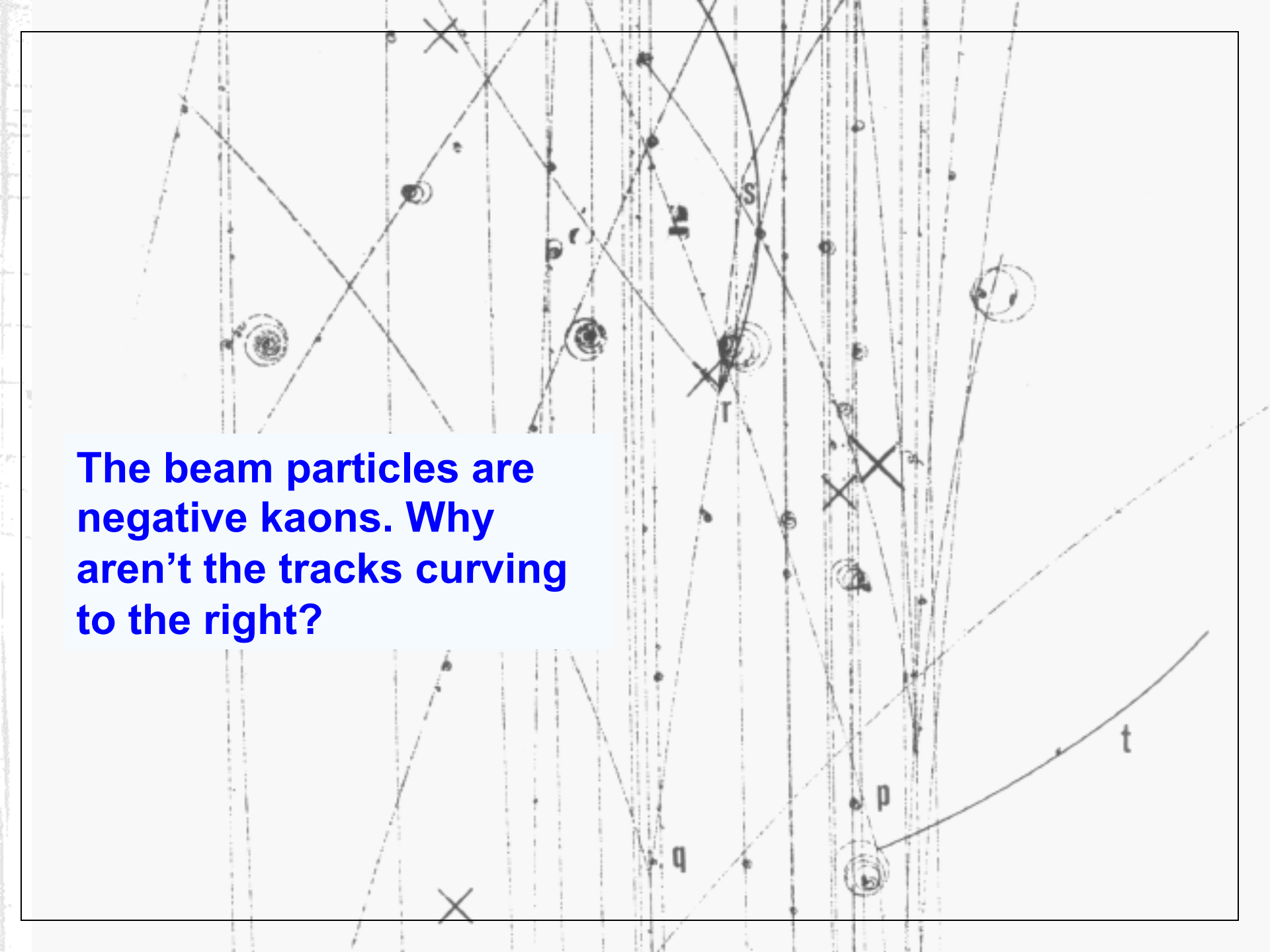
a) large circles

b) large spirals

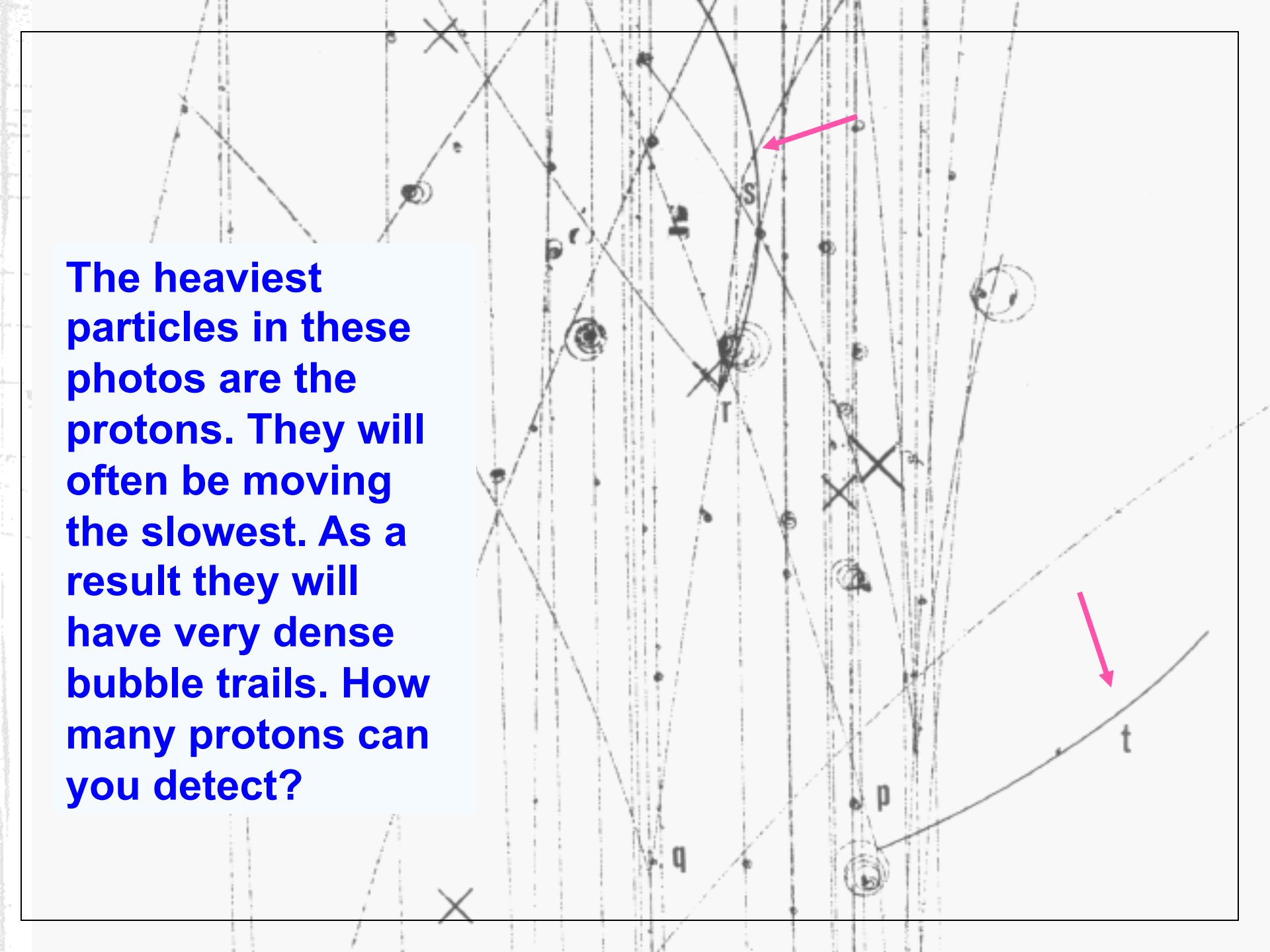
c) small circles

d) small spirals

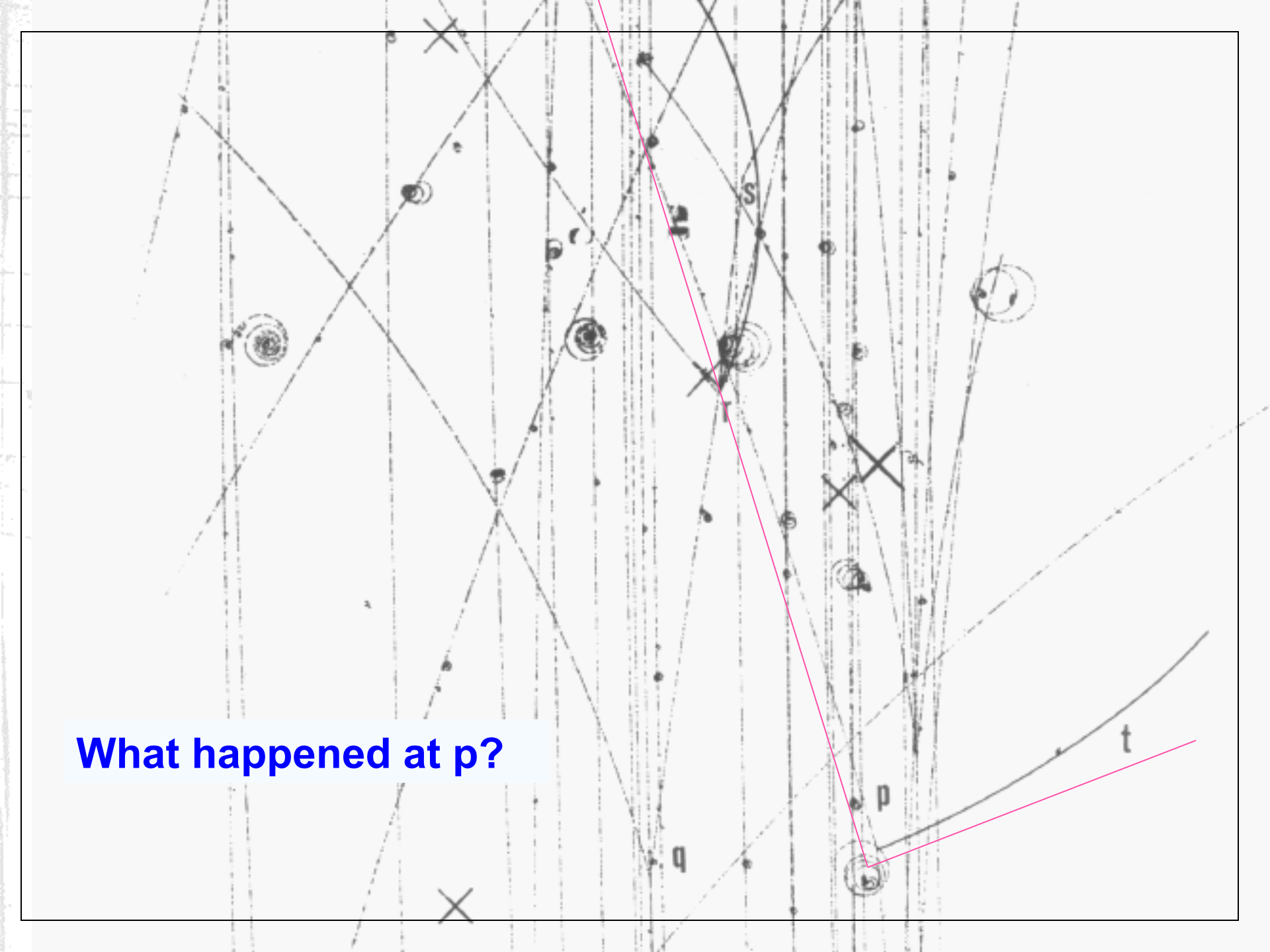
If they radiate energy they must be losing energy and slowing down.



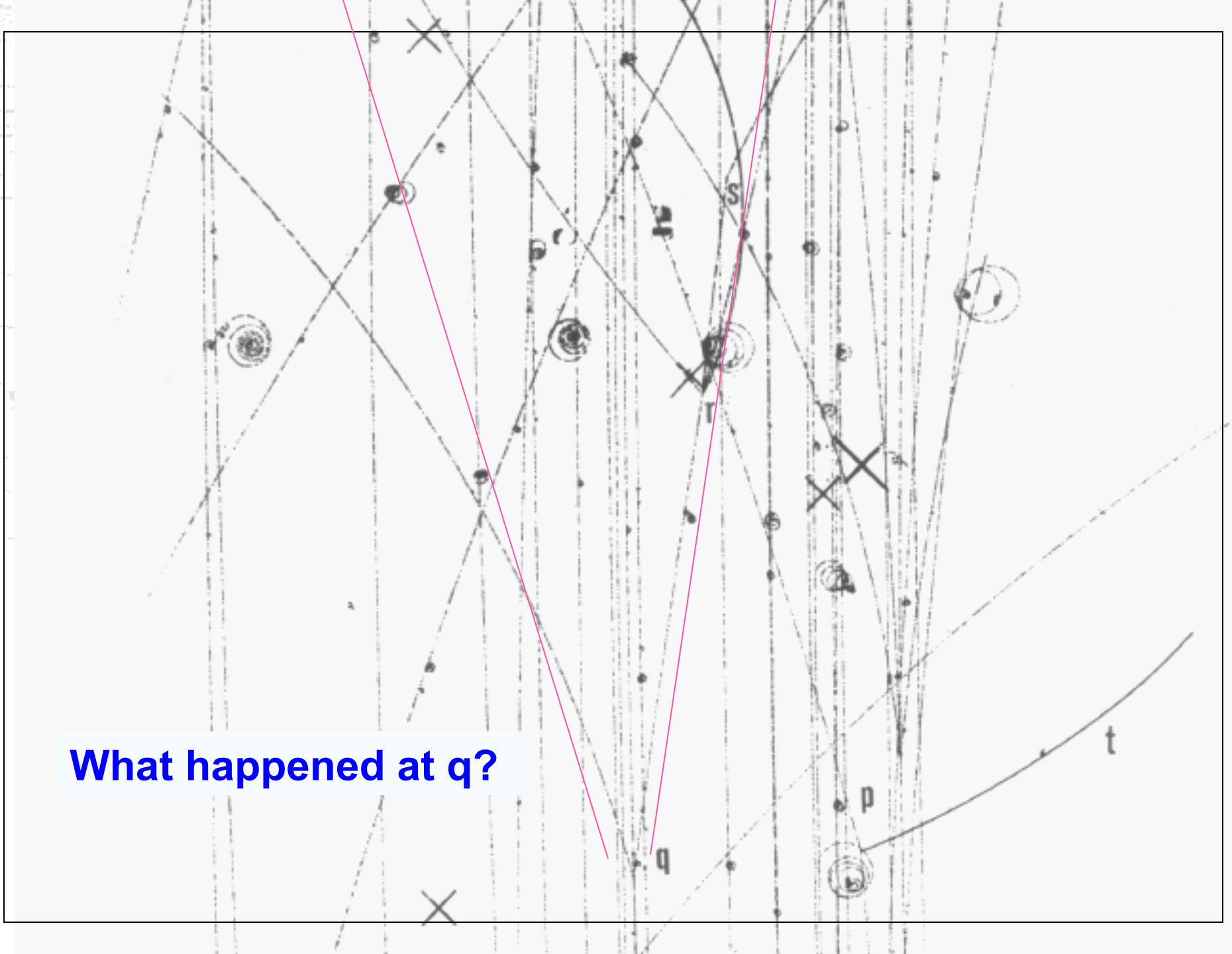
The beam particles are negative kaons. Why aren't the tracks curving to the right?



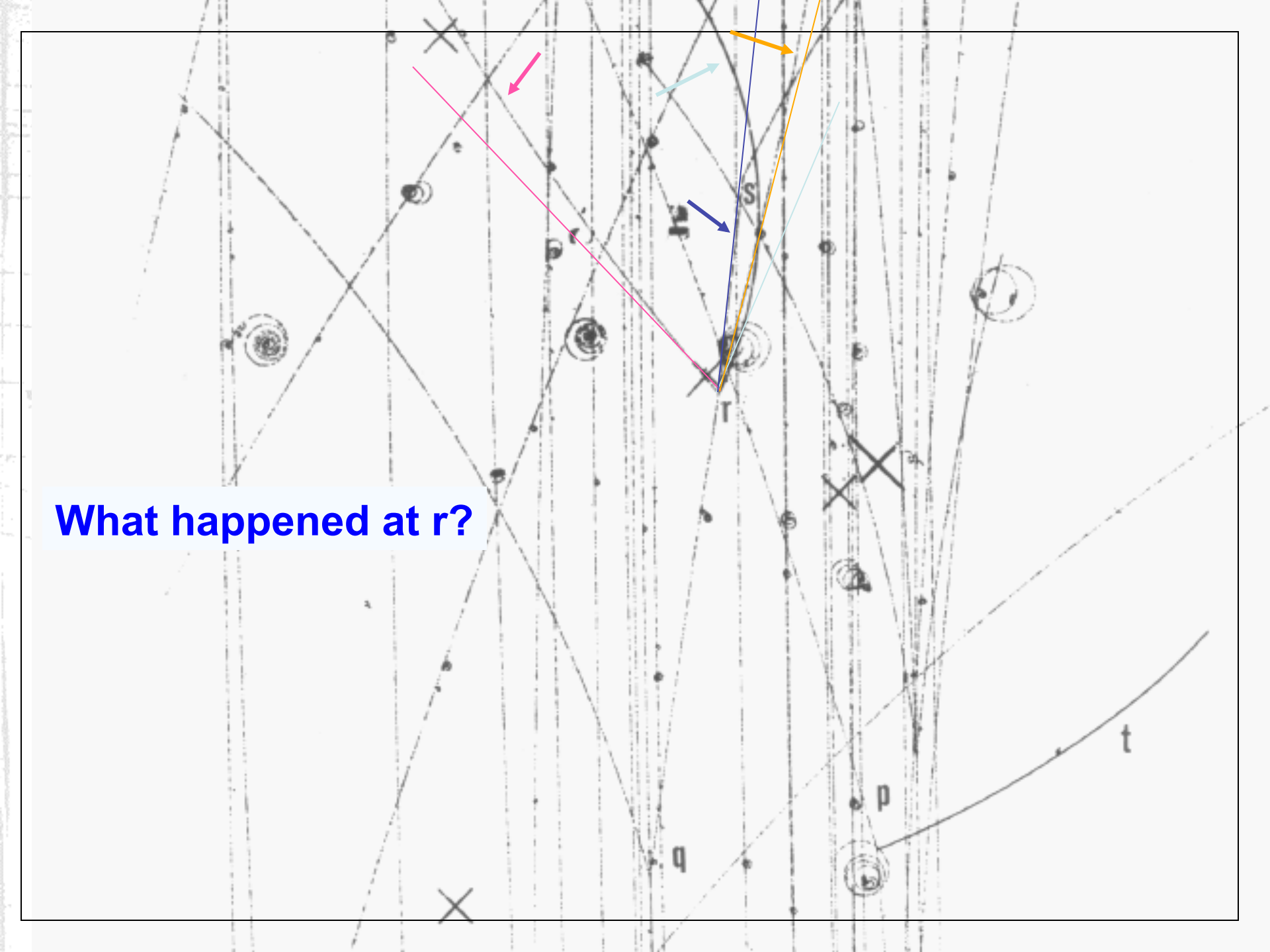
The heaviest particles in these photos are the protons. They will often be moving the slowest. As a result they will have very dense bubble trails. How many protons can you detect?



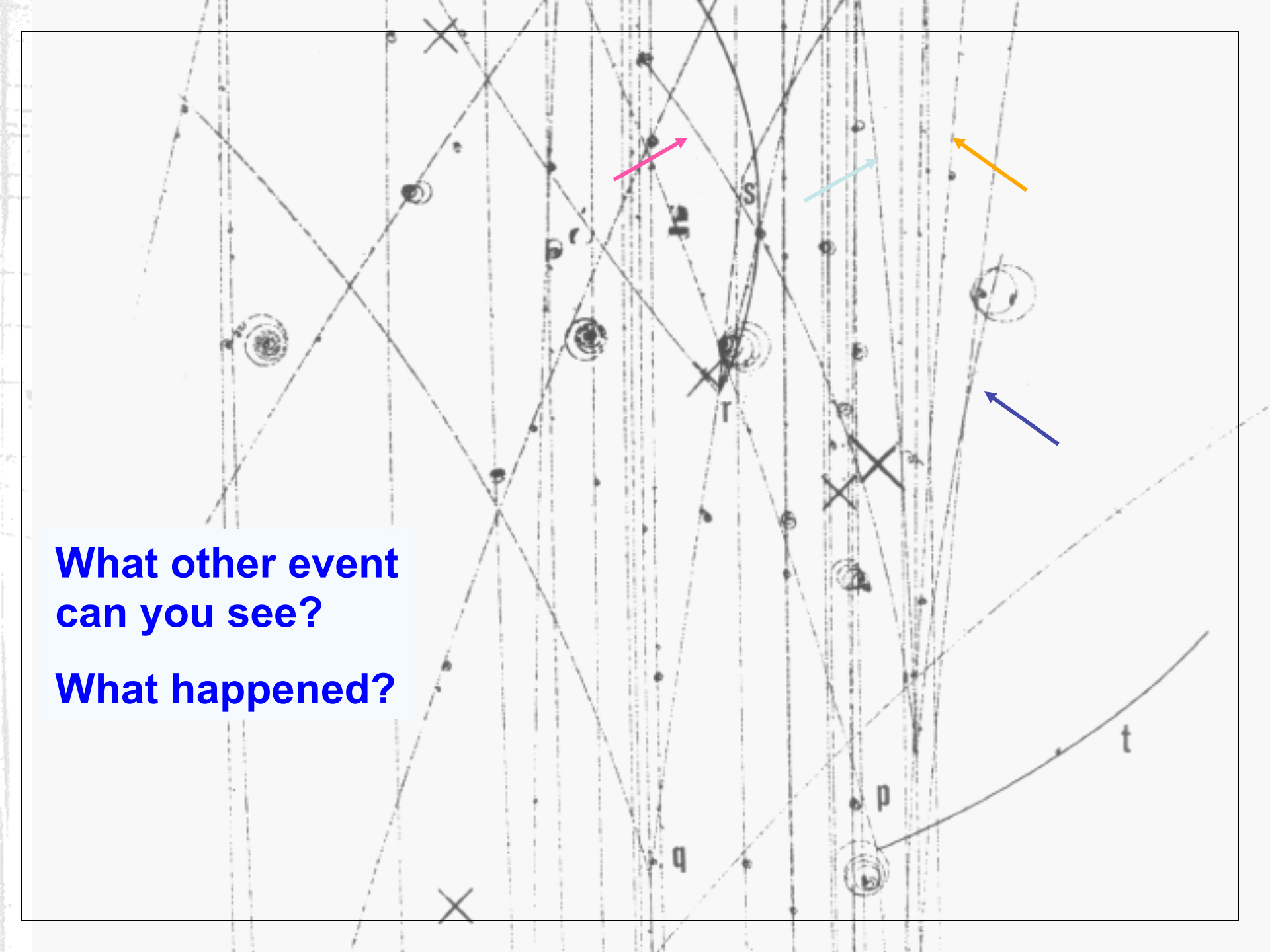
What happened at p?



What happened at q?



What happened at r?



What other event can you see?

What happened?