

Nuclei and particles

(100 s)

1 What are the nuclei made of, and how are they held together?

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3 It's found that the nuclei are held together by enormous forces. When
4 those are released, the energy released is enormous compared with
5 chemical energy, in the same ratio as the atomic bomb explosion is to a
6 TNT explosion, because, of course, one of them, (A

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8 while the chemical explosion of TNT has to do with (B

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11 The question is, what are the forces which hold the protons and
12 neutrons together in the nucleus? Just like electrical interaction was due
13 to a ..., can be represented in a way as the exchange of photons in the
14 electric field, well there is an electric field between the two, and these are
15 connected to a particle of photon, in quantum mechanics, so Yukawa
16 suggested that the forces between neutrons and protons have also got a
17 field of some kind, and that when this field jiggles it behaves like a
18 particle, and that there should be some other particles in the world besides
19 protons and neutrons. And he was able to deduce the properties of these
20 particles from the characteristics already known of nuclear forces. For
21 instance, they should have a mass of two or three hundred times that of
22 an electron and so on; and lo and behold, in cosmic rays they discovered

23 a particle of the right mass! But I wouldn't chase this

24 around; it turned out to be the wrong particle. It was called a μ -meson, or
25 muon. It's not the right particle.

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27 But a little while later, in 1947 or 8, another particle was found, the π -
28 meson, which satisfies Yukawa's criterion. So that besides the proton and
29 the neutron, (C

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33 R.P. Feynman, *Six Easy Pieces* (Addison-Wesley, 1995) pp. 38-39.

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36 TNT: trinitrotoluene

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42 jiggle: to move from side to side with short quick motion

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44

45 lo and behold: いやはやこれは驚いた