907.

Problem 56.9 (RHK)

We have to calculate the range of the weak force between two neighbouring protons. We may assume that Z^0 *is the field particle. The mass of* Z^0, $m_{Z^0}c^2 = 91.2 \text{ GeV}$.

Solution:

Let the observation time for measuring the range of the weak force be Δt. As weak force between the protons is assumed to be due to the exchange of Z^0, the time Δt is determined by the uncertainty principle with $\Delta E = m_{Z^0}c^2 = 91.2 \text{ GeV}$. We have

$$\Delta t = \frac{\text{h}}{\Delta E} = \frac{6.582 \times 10^{-22} \text{ MeV s}}{91.2 \times 10^3 \text{ MeV}} = 7.22 \times 10^{-27} \text{ s.}$$

Assuming that field mediates with speed of light, the range of weak force between two protons will be

$$r_{\text{weak force}} = c\Delta t = 3 \times 10^8 \times 7.22 \times 10^{-27} \text{ m}$$
$$= 2.16 \times 10^{-18} \text{ m.}$$