433(2): Scheme for the Determination of the Number of Elementary Particles.

First consider the equation:

$$E^2 = p^2c^2 + m(r)\,m^2c^4 \quad -(1)$$

So the $m(r)$ function is:

$$m(r) = \frac{E^2 - p^2c^2}{m^2c^4} \quad -(2)$$

where

$$p = \gamma m v = \left(1 - \frac{v^2}{c^2}\right)^{-1/2} m v \quad -(3)$$

where

$$v = \frac{dr}{dt} \quad -(4)$$

So $m(r)$ depends on r and $dm(r)/dr$ is non-zero. In m theory this is a requirement for a non-zero strong force.

By experiment the rest energy m_1c^2 of the $\pi^\pm$ pion is:

$$E_1 = m_1c^2 = 2.236 \times 10^{-11}\ J \quad -(5)$$

and the rest energy of the π^0 pion is:

$$E_2 = m_2c^2 = 2.163 \times 10^{-11}\ J \quad -(6)$$

The reason for the existence of three pions is given by

$$E^2 - p^2c^2 = m^2c^4 \int \phi^* m(r)\, \phi\, d\tau \quad -(7)$$

$$= m^2c^4 \langle m(r) \rangle$$

Is the expectation value:

2)

$$\langle m(r)\rangle = \int \phi^* m(r)\, \phi \, d\tau \quad -(8)$$

So the pion rest energies are given by:

$$\boxed{m^2c^4 = \frac{E^2 - p^2c^2}{\langle m(r)\rangle}} \quad -(9)$$

In the preceding note this result was quantized to:

$$m^2c^4 = \frac{(\hbar\omega)^2 + \hbar^2c^2\int \phi^* \nabla^2 \phi \, d\tau}{\int \phi^* m(r)\, \phi \, d\tau} \quad -(10)$$

By experiment, there are three pions $\pi^{\pm}$ and π^0, with energy levels given by eqs. (5) and (6). The energy levels of π^+ and π^- are the same, and that of π^0 is different. So in summary:

$$\pi^{\pm} : E_{01}^2 = m_1^2c^4 = \frac{E_1^2 - c^2p_1^2}{m_1(r)} \quad -(11)$$

$$\pi^0 : E_{02}^2 = m_2^2c^4 = \frac{E_2^2 - c^2p_2^2}{m_2(r)} \quad -(12)$$

The values of $m_1(r)$ and $m_2(r)$ may be obtained from eq. (8) using a model for $m(r)$. The integral:

$$\langle m(r) \rangle = \int \phi^* m(r) \phi \, d\tau \quad -(13)$$

must produce three values of $m(r)$:

$$m_1(r) = m_2(r), \text{ and } m_3(r) \quad -(14)$$

In order to obtain ϕ from eq. (4), the model $m(r)$ may be used, and m in eq. (4) inputted as a parameter. For example it could be the mean mass:

$$m = \frac{1}{2} \left(m(\pi^{\pm}) + m(\pi^{0}) \right) \quad -(15)$$

determined experimentally.

The important advance in understanding is that the reason why there are three pions is given by the expectation value (8).

In the old physics the reason for the existence of three pions is in terms of SU(2) flavour symmetry, or isospin. The three pions came from the triplet 3 of the representation, the adjoint representation of the SU(2) group. So the old physics depended on group theory and symmetry. The old physics does not really work, because some of its claimed symmetries are "approximate". A symmetry is either precise or does not exist.