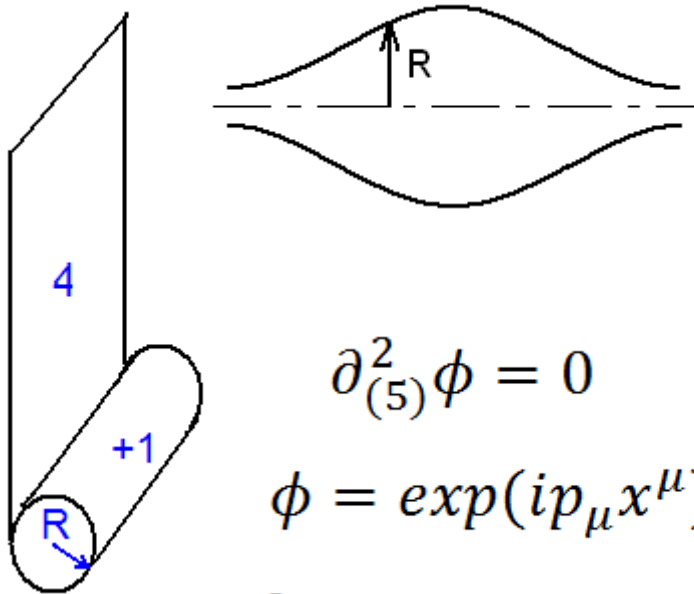


# 1. Model of the Kaluza -Klein . Main consequences and possibilities to test.

$$g_{MN} = \begin{pmatrix} g_{\mu\nu} & g_{\mu n} \\ g_{m\nu} & g_{mn} \end{pmatrix} \quad \begin{array}{l} M, N = 0, \dots D \\ \mu, \nu = 0, \dots 3 - \text{Minkovsky space} \\ m, n = 4, \dots D - \text{extra dimensions (named d)} \end{array}$$



$R$  – compactification radius

$R = \text{const}$  – extra dimensions are manifested in form of the KK-mass states for all particles

$R \neq \text{const}$  – in form of interaction

$$\partial_{(5)}^2 \phi = 0$$

$$\phi = \exp(ip_\mu x^\mu) \exp\left(\frac{inZ}{R}\right) \quad n = 0, \pm 1, \pm 2 \dots$$

$Z$  – one cylindrical extra dimension

$$p^2 = \frac{n^2}{R^2} \Rightarrow m_n = \frac{|n|}{R} - \text{KK-mass states}$$

Modern experiment restricts extra dimension manifestation as  $1/R > \sim 100 \text{ GeV} \Rightarrow \Rightarrow R < 10^{-17} \text{ cm}$ , i.e. extra dimension(s) should be very compact (with microscopic size).

## 2. Mechanism of neutrino mass generation

“See-saw” mechanism of generation neutrino mass

$$\Delta L_m = m_D (\bar{\nu}_L \nu_R + \bar{\nu}_R \nu_L) + m_R (\bar{\nu}_R^c \nu_R + \bar{\nu}_R^c \nu_R)$$

Dirac term

Majorana term

$$\begin{cases} v_1 = \frac{v_L + v_L^c}{\sqrt{2}} \\ v_2 = \frac{v_R + v_R^c}{\sqrt{2}} \end{cases} \xrightarrow{\text{Diag.}} \Delta L_m = m_1 (\bar{\nu}_1^c v_1 + \bar{\nu}_1^c v_1) + m_2 (\bar{\nu}_2^c v_2 + \bar{\nu}_2^c v_2)$$

$$m_D \ll m_R \Rightarrow m_1 \approx \frac{m_D^2}{m_R}; m_2 \approx m_R$$

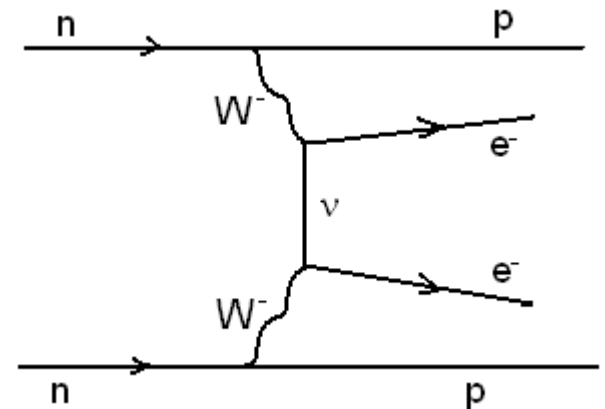
$$\begin{aligned} m_D &\sim v_W \sim 100 \text{ GeV} \\ m_R &\sim \Lambda_{\text{GUT}} \sim 10^{15} \text{ GeV} \end{aligned} \Rightarrow m_1 \sim 0.1 \text{ eV}$$

Consequence:

Majorana term violates lepton number conservation =>

=> Processes with  $\Delta L=2$  are allowed =>

=> neutrinoless double  $\beta$ -decay



Spontaneous breaking of symmetry of lepton charge implies the existence of Nambu-Goldstone boson – Majoron.