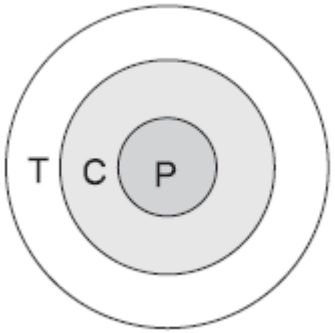
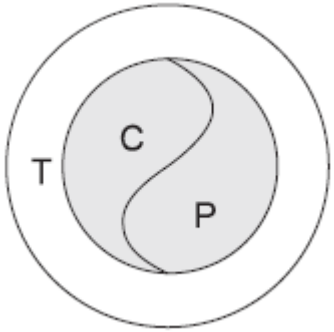
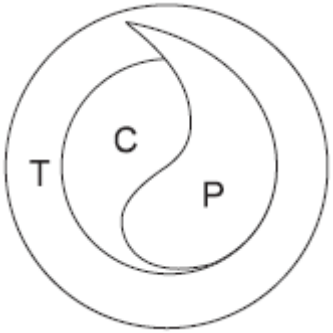






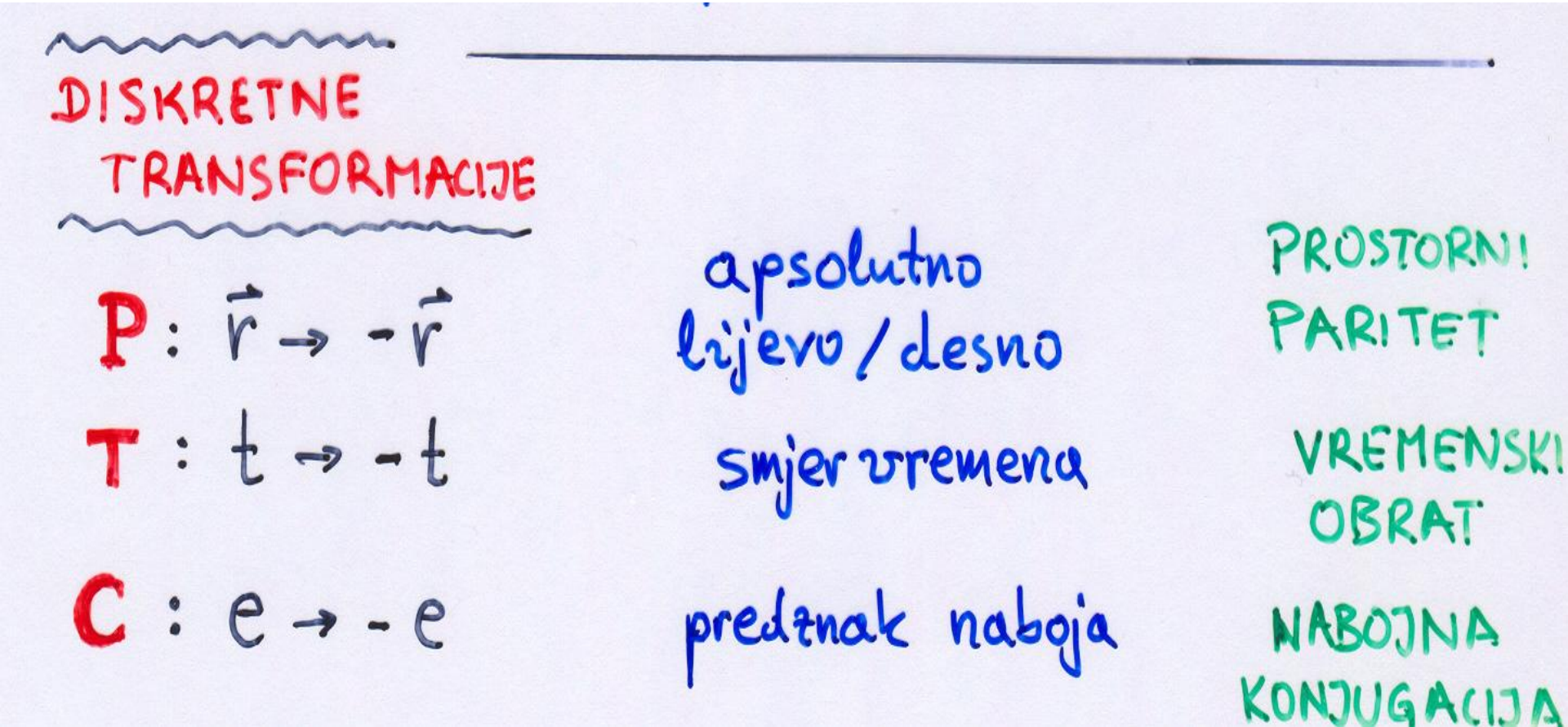
IV. PRIBLIŽNE SIMETRIJE JAKIH, EM i SLABIH PROCESA

- DISKRETNE PROST-VREM. TRANSFORMACIJE
- NABOJNA KONJUGACIJA
- KOMBINIRANE TRANSFORMACIJE CP i CPT

POJAM PRIBLIŽNE SIMETRIJE

- JAKO MEĐUDJELOVANJE POKAZUJE NAJVIŠE SIMETRIJA
- OD NABOJNE SIMETRIJE JAKE SILE DO IZOSPINA
  (FEČ § 2.1.3 str. 58)
- OD IZOSPINA DO OKUSA
  (FEČ § 4.1.2, str. 188)

DISKRETNE SIMETRIJE I MULTIPLIKATIVNI ZAKONI OČUVANJA



PROSTORNI PARITET

$$P\psi(\vec{r}) = \begin{cases} \psi(-\vec{r}) \\ \eta_P \psi(\vec{r}) \end{cases}$$

$$\begin{aligned} P\mathbf{r}_{op}P^{-1} &= -\mathbf{r}_{op} \\ P\mathbf{p}_{op}P^{-1} &= -\mathbf{p}_{op} \\ P\mathbf{L}P^{-1} &= \mathbf{L} \end{aligned}$$

$$PY_l^m(\theta,\varphi) = Y_l^m(\pi-\theta,\varphi+\pi) = (-)^l Y_l^m$$

$$[H_{hadr} + H_{em}, P] = 0$$

$a + b \to c + d \quad \Pi_i = \Pi_a \Pi_b (-)^l, \qquad \Pi_f = \Pi_c \Pi_d (-)^{l'}$

Paritet piona iz:

$$(a) \qquad d\,\pi^- \to n\,n$$

$$(b) \qquad d\,\pi^- \to n\,n\pi^0$$

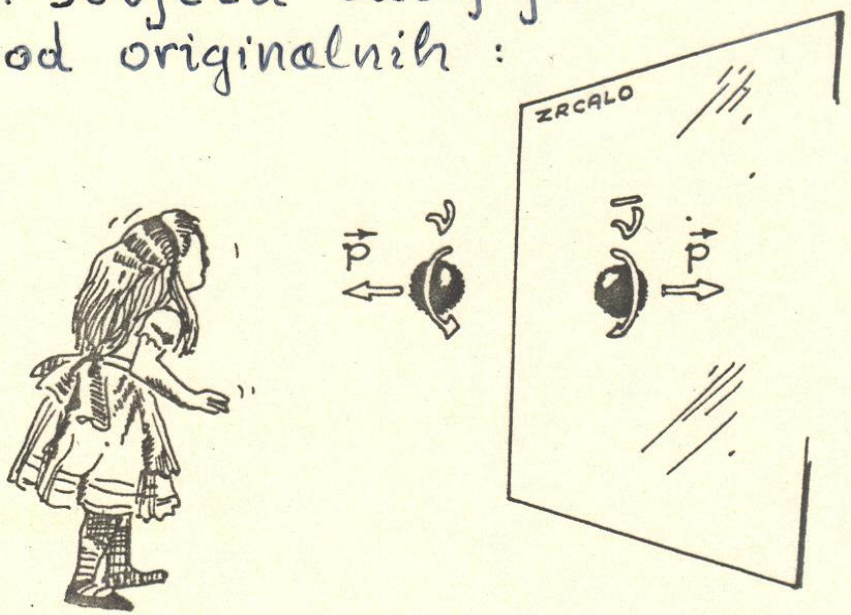
"PUKOTINE U SIMETRIJAMA"
- najprije prostorni paritet

NARUŠENE DISKRETNE SIMETRIJE

KLJUČ OPAŽANJA
"SLABIJEG KRUG JAČE"

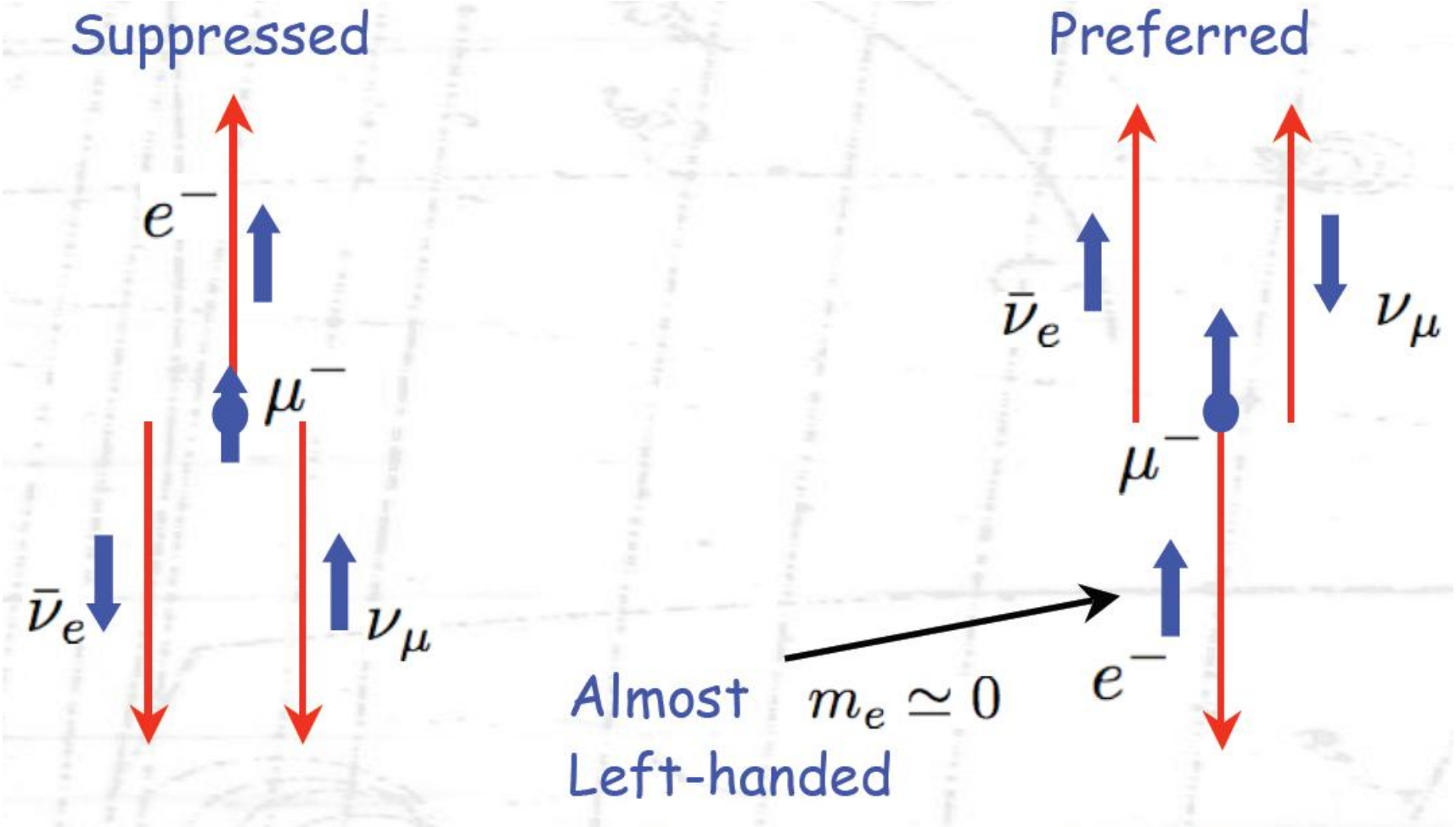
P

1957. g-đa Wu ustanovila da se β-raspadi u zrcaljenom svijetu odvijaju različito od originalnih :



L. Lederman, “How we violated parity”, p.256 , God particle;

Iz kutne raspodjele elektrona može se odrediti omjer V i A doprinosa



VREMENSKI OBRAT

$$T : t \rightarrow -t,$$

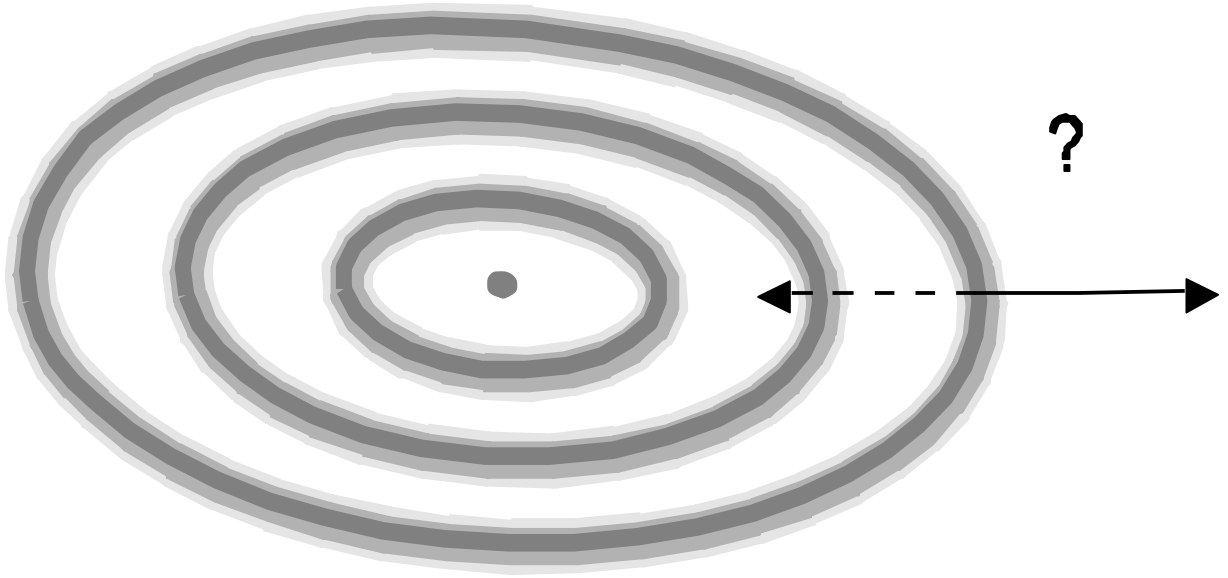
$$\psi(\vec{x},t) \rightarrow T\psi(\vec{x},t) \qquad T\psi(\vec{x},t) = \psi^*(\vec{x},-t)$$

ODGOVARA OBRATU GIBANJA:

$$|\vec{p}\rangle \rightarrow |-\vec{p}\rangle$$

$$\psi = e^{i(\vec{p}\cdot\vec{x}-Et)} \rightarrow \psi^*(\vec{x},-t) = e^{i(-\vec{p}\cdot\vec{x}-Et)}$$

VREMENSKI OBRAT?



NABOJNA KONJUGACIJA

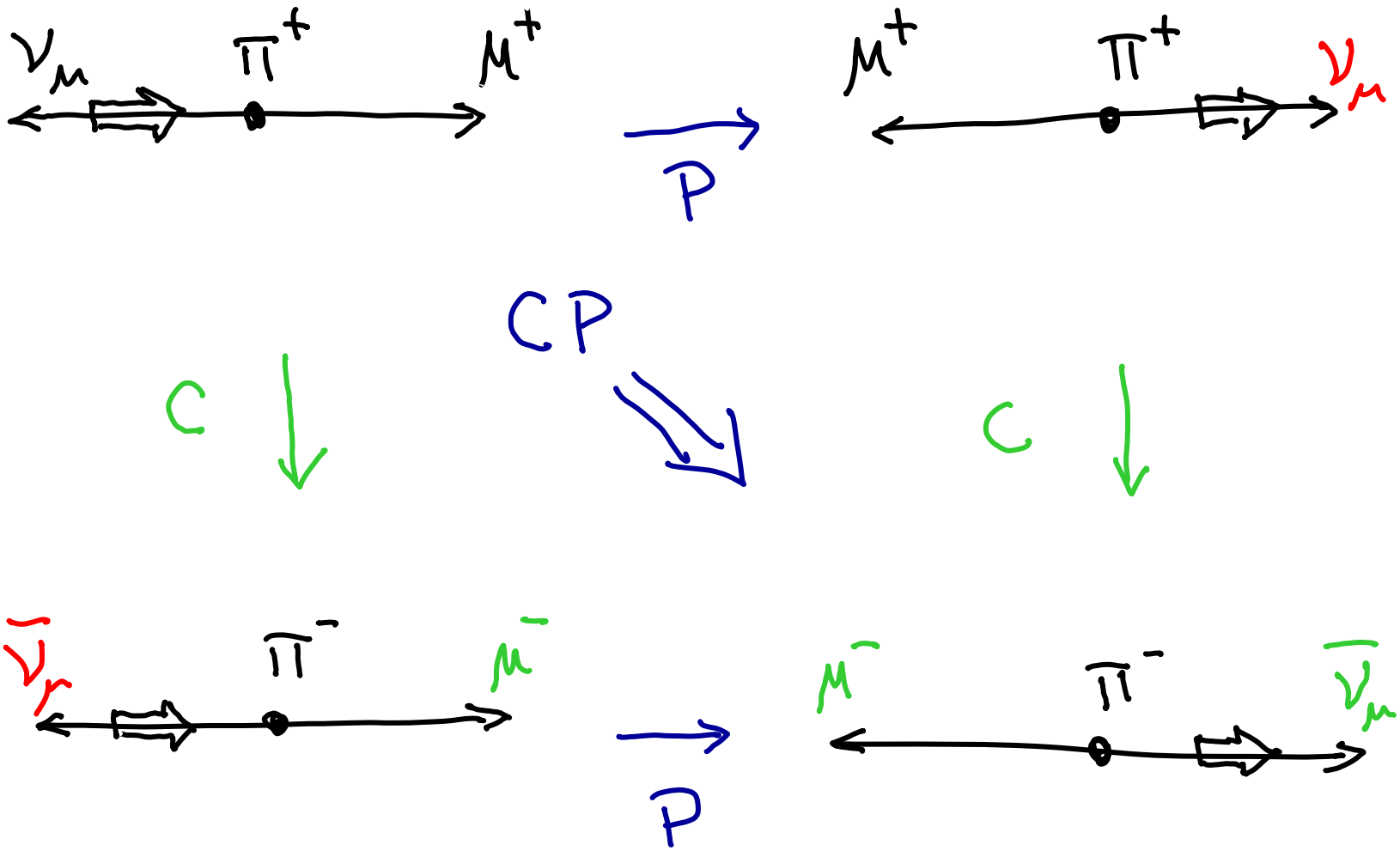
$$C|B(L), Y, q; \vec{p}, s\rangle = \eta_c| - B(-L), -Y, -q; \vec{p}, s\rangle$$

$$Q \text{ i } C \text{ (gdje } Q|q\rangle = q|q\rangle \text{ i } C\,|q\rangle = |-q\rangle)$$

$$\begin{aligned} \{C, Q\} &= 0\,, \\ [C, Q] &= 2CQ \neq 0\,. \end{aligned}$$

C-paritet fotona i neutralnog piona

- VREMENSKA MIKRO-OBRATIVOST
  kombinirani CP paritet


ν_μ
π^+
μ^+
P
μ^+
π^+
ν_μ
CP
C
C
$\bar{\nu}_\mu$
π^-
μ^-
P
μ^-
π^-
$\bar{\nu}_\mu$

Narušenje CP pariteta, VREMENSKE MIKROOBRATIVOSTI

~~CP~~ 1964. Cronin & Fitch

na raspadima dugoživućih neutralnih kaona

- $K_L \not\to 2\pi$ ako je CP očuvano

  u pokusu se pojavljuje s granicom $2 \cdot 10^{-3}$

- $K_L \to \pi^- e^+ \nu_e$ češći od CP-konjugiranog $K_L \to \pi^+ e^- \bar{\nu}_e$

omogućuje apsolutnu definiciju pozitivnog naboja

– razlikovanje materije i antimaterije !

CPT = I teorem poturden na točnost

$$\frac{m_{\bar{K}^0} - m_{K^0}}{m_{K^0}} < 3.5 \cdot 10^{-18} \leq 9 \cdot 10^{-19}$$