Suppose physics is invariant under (linear) transformation: $\psi \rightarrow \psi' = U\,\psi$

$U^\dagger = U^{T*}$

Ensure normalization: $\int \psi^\dagger \psi \, d^4x = 1 \Rightarrow \int \psi^\dagger U^\dagger U \psi \, d^4x = 1$

$\Rightarrow U^\dagger U = 1 \Rightarrow$ U has to be unitary

To ensure physics is invariant under transformation:

$$\int \psi^\dagger H \psi \, d^4x = \int \psi'^\dagger H \, \psi' d^4x = \int \psi^\dagger U^\dagger H U \psi \, d^4x$$

$\Rightarrow H = U^\dagger H U \Rightarrow UH = HU \Rightarrow [H, U] = 0$

Now consider infinitesimal transformation: $U = 1 + i\,\varepsilon\,G$ G: generator of transformation

$U^\dagger U = (1 - i\varepsilon G^\dagger)(1 + i\varepsilon G) = 1 + i\varepsilon(G - G^\dagger) + O(\varepsilon^2)$

$U^\dagger U = 1 \Rightarrow G = G^\dagger \Rightarrow$ G is hermitian, thus coresponds to an observable quantity g

$[H,U] = 0 \Rightarrow [H,G] = 0 \Rightarrow$ g is a conserved observable quantity!

For each infinitesimal transformation which conserves the physics of the system, there is a conserved observable!

# Theta -Tau Rätsel

In 1956, parity conservation as well as T and C symmetry was a "dogma"

$\longrightarrow$ very little experimental tests done

$\theta/\tau$ puzzle:

$\theta \to \pi^+\pi^0$; P($\pi^+\pi^0$) = +1

$\tau \to \pi^+\pi^+\pi^-$; P($\pi^+\pi^+\pi^-$) = -1

P($q$) = 1; P($\bar{q}$) = -1;

P(meson) = $P_q P_{\bar{q}}(-1)^L$;

lowest energy, $S = 0$

P=-1

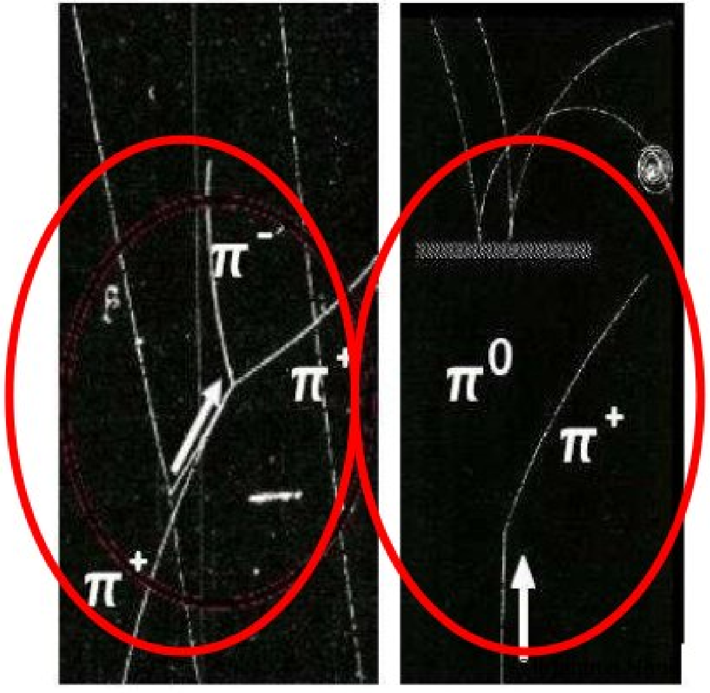
$\theta$, $\tau$ have same mass, same lifetime, however different parity ...

Yang, Lee:

$\to \theta = \tau = K^+$

weak interaction violates parity

proposed a set of measurements which test parity



# Ergebnisse: Wu-Experiment