Chiral Lagrangian

- QCD at low energy is a theory of interacting Goldstone modes
- This theory should have the same symmetries as QCD
- $U(N_c) \times U(N_c) \rightarrow U(N_c)$
  - Spontaneous breaking
  - Lorentz invariant

Quark mass in QCD:

\[ \bar{\psi}_L \psi_R + \bar{\psi}_R \psi_L \]

Becomes invariant if:

\[ m \rightarrow U + m U^{-1} \]
\[ \bar{m} \rightarrow U \bar{m} U^{-1} \]

And:

\[ \psi_L \rightarrow U_L \psi_L \]
\[ \psi_R \rightarrow U_R \psi_R \]
\[ \bar{\psi}_L \rightarrow \bar{\psi}_L U^{-1} \]
\[ \bar{\psi}_R \rightarrow \bar{\psi}_R U^{-1} \]

The low energy effective theory also should have this symmetry.

The Goldstone modes transform as:

\[ \Sigma \rightarrow U_L \Sigma U_R^{-1} \]