higher hadron physics Exercise 6 Julian Bergmann

Nr 3

Chiral symmetry is a possible symmety of the Lagrangian. As chiral is greek for hand, it is affecting the transformation of right- and left-handed parts of the dirac field. Within this, vector symmetry is known to treat the components indifferent, contrary to the axial symmetry. Regarding masses, chiral symmety is almost always broken, explicitely for normal masses and spontaneously for low and zero masses.

Explicit symmetry breaking is, regarding to a symmetry within the Lagrangian, making the kinematic therm assymmetrically. For explicit breaking, symmetry is violated in all states.

Spontanous symmetry breaking occurs when ground state still has the symmetry but an exited state breaks the symmetry. The ground state has less symmetries than the cinematic therm.

Simplifying, a spontaneous symmetry breaking follows when a system with an instable ground state gets little disturbance, so it goes into an energetic better state, which doesn't support the symmetry anymore.

Explicit symmetry breakings have much less disturbance and are often ignored as the symmetry therms are often much greater in value.

A more explicit rule gives the Coleman-Theorem:

- Is the Lagrangian and the ground state invariant, then the system is symmetric.
- Is Lagrangian still invariant but the groundstate not anymore, then the system has spontaneous symmetry breaking
- Is both not invariant anymore, is the system explicit symmetry broken.

Another theorem is the Goldstone-Theorem:

At symmetry breaking (on global scale) appear always massless pseudoscalar particles (Goldstone-Bosons).

is the right kiral system and ground state chosen, then 3 Goldstone-Particles are detected: π^-, π^0, π^+.

A 4. is not detected as the fourth degree of freedom is already occupied by the ground state.

Higgs also told us that within a calibration symmetry (spontaneous symmetry breaking) (on a local scale) the goldstone bosons (Higgs) arent appearing directly but interacting with the field, so it absorbs the degrees of freedom and becomes massive. This leads to the mass of a field.