Examining the Electroweak Interactions Gauge Theory

 1st Year Master Theoretical Physics: 2021-2022

# Exercise N1 1: 10 pts

I- We consider the group symmetry  : 3 pts

1-Determine the order of the group, and write down the different properties of the algebra associated with this group .

2- Give the fields that are included in the strong interaction model,

3-Give the Lagrangian density which decries the local symmetry

II-Consider the following Lagrangian: 3 pts

ℒ=

Which transforms like  a double under global symmetry:  

1-Find the state of vacuum in the case: .

2-Consider small perturbations around the vacuum to determine the masses of these excitations, what is the residual symmetry in the case . Apply Gladstone's theorem.

 III-If the Lagrangian expression (complex scalar field ): 4 pts

ℒ=



Study the local symmetries found after spontaneous symmetry breaking.

# Exercise N0 2: 10 pts

1-Write the expression of the Lagrangian density associate or coupling group:



2-Give the fields that are included in the standard model

3-Write the transformations of the fields which are included in the Electroweak model.

4- Give the effect of the covariant derivative on the fields that are included in the Electroweak model

5-Write and interpret the Lagrangian density after the spontaneous breaking of the symmetries associated with the bosonic spectrums.

6- Write the Lagrangian expression associated with density or group:

 (Standard model)

7- Give the effect of the covariant derivative on the fields that are included in the Standard model.

**(One and a half points for each correct answer)**



Typical correction of the Electroweak Interactions Gauge Theory 1st Year Master

Theoretical Physics: 2021-2022

I- We consider the group symmetry :

1-The order of the group  , for any  group, we have in our case  :



The different properties of the algebra associated  :



2- The fields that are included in the strong interaction model:



And 

3-The Lagrangian density which decries the local symmetry ℒ

II-Consider the following Lagrangian:

ℒ

Which transforms like a double under global symmetry:  

1-The state of vacuum in the case  :



2-Consider small perturbations around the vacuum to determine the masses of these excitations:

 ℒ= 



III-If the Lagrangian expression (complex scalar field  ):

The local symmetries found after spontaneous symmetry breaking:



ℒ 

If we set  , after straightforward calculations we obtain:

ℒ 



# Exercise N0 2: 10 pts

1-Write the expression of the Lagrangian density associate or coupling group : 

ℒEW=



with



and



and



and



2-The fields that are included in the standard model

12-fermions with spin-1/2:  ;  ; 

Quarks:



Gauge bosons:

3 W  and Z  with spin-1 for week interactions 1  with spin-1 for electromagnetic interactions

8  gluons with spin-1 for strong interactions 1  Higgs

3-Write the transformations of the fields which are included in the Electroweak model.



4- Give the effect of the covariant derivative on the fields that are included in the Electroweak model



5-The Lagrangian density after the spontaneous breaking of the symmetries associated with the bosonic spectrums

ℒ=



with



6- The Lagrangian expression associated with density or group :  (Standard model)

ℒSM=



7- The effect of the covariant derivative on the fields that are included in the Standard model



