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HIGGS BOSON MASS IN THE MINIMAL UNIFIED SUBQUARK MODEL

In the minimal united subquark model of all fundamental particles and forces, the mass of the Higgs boson in the standard model of electroweak interactions (m_H) is predicted to be about $2m_W\sqrt{6}/3$ (where m_W is the mass of the charged weak boson) so that m_H = 131 *GeV* for m_W = 80.4 *GeV*, to which the experimental values of 125-126 *GeV* recently found by the ATLAS and CMS Collaborations at the LHC are very close.

Key words: elementary particles, Higgs-boson.

What most of us can expect to find in high energy experiments at the Large Hadron Collider is the Higgs boson (H), which is the only fundamental particle that has not yet been found in the standard model of electroweak interactions [1]. In the united composite model of all fundamental particles and forces [2], the mass of the Higgs boson has been predicted in the following three ways.

In general, in composite models of the Nambu-Jona-Lasinio type [3], the Higgs boson appears as a composite state of fermion-antifermion pairs with the mass twice as much as the fermion mass. The united subquark model of the Nambu-Jona-Lasinio type [4] has predicted the following two sum rules:

$$m_W = \left[3\left(m_{w_1}^2 + m_{w_2}^2\right)/2\right]^{\frac{1}{2}}$$

and

$$m_H = 2\left[\left(m_{w_1}^4 + m_{w_2}^4\right)/\left(m_{w_1}^2 + m_{w_2}^2\right)\right]^{\frac{1}{2}}$$

where m_{w_1} and m_{w_2} are the masses of the weak-iso-doublet spinor subquarks called "wakems" standing for weak and electromagnetic (w_i for i = 1,2) while m_W and m_H are the masses of the charged weak boson (W) and physical Higgs boson in the standard model, respectively. By combining these sum rules, the following relation has been obtained if $m_{w_1} = m_{w_2}$:

$$m_w : m_W : m_H = 1 : \sqrt{3} : 2.$$

From this relation, the wakem and Higgs boson masses have been predicted as

$$m_w = m_W/\sqrt{3} = 46.4\ GeV$$

and

$$m_H = 2m_W/\sqrt{3} = 92.8\ GeV$$

for m_W = 80.4 *GeV* [5]. On the other hand, if $m_{w_1}/m_{w_2} = 0$ or $m_{w_2}/m_{w_1} = 0$ but not both, the other relation can be obtained:

$$m_w : m_W : m_H = 1 : \sqrt{3/2} : 2.$$

From this relation, the non-vanishing wakem and Higgs boson masses can be predicted as

$$m_w = m_W\sqrt{3/2} = 65.6\ GeV$$

and

$$m_H = 2m_W/\sqrt{3/2} = 131\ GeV$$

for m_W = 80.4 GeV [5]. More generally, from the two sum rules, the Higgs boson mass can be bounded as

$$92.8\ GeV = 2m_W/\sqrt{3/2} \le m_H \le 2m_W\sqrt{6}/3 = 131\ GeV.$$

In the unified quark-lepton model of the Nambu-Jona-Lasinio type [4], the follow-ing two sum rules for m_W and m_H have been predicted:

$$m_W = (3 < m_{q,l}^2 >)^{1/2}$$

and

$$m_H = 2\left(\Sigma m_{q,l}^4 / \Sigma m_{q,l}^2\right)^{1/2},$$

where m_{ql}'s are the quark and lepton masses and <> denotes the average value for all the quarks and leptons. If there exist only three generations of quarks and leptons, these sum rules completely determine the top quark and Higgs boson masses [6] as

$$m_t \cong (2\sqrt{6}/3)\, m_W = 131\ GeV$$

and

$$m_H \cong 2m_t \cong (4\sqrt{6}/3)\, m_W = 263\ GeV.$$

Furthermore, triplicity of hadrons, quarks, and subquarks [7] tells us that these sum rules can be further extended to the approximate sum rules of

$$m_W \cong (3 < m_{B,l}^2 >)^{1/2}$$

and

$$m_H \cong 2\left(\Sigma m_{B,l}^4 / \Sigma m_{B,l}^2\right)^{1/2},$$

where $m_{B,l}$'s are the "canonical baryon" and lepton masses and <> denotes the average value for all the canonical baryons and leptons. The "canonical baryon" means either one of *p,n* and other ground-state baryons of spin 1/2 and weak-isospin 1/2 consisting of a quark heavier than the u and d quarks and a scalar and isoscalar diquark made of u and d quarks. If there exist only three generations of quarks and leptons, these sum rules completely determine the masses of the canonical topped baryon, *T*, and the Higgs scalar as

$$m_T \cong 2m_W = 161\ GeV$$

and

$$m_H \cong 2m_T \cong 4m_W = 322\ GeV.$$

Therefore, if the Higgs boson is found with the mass between 92.8 *GeV* and 131 *GeV*, it looks like a composite state of subquark-antisubquark pairs. If it is found heavier with m_H around 263 *GeV* or even 322 *GeV*, it can be taken as a bound state of $t\bar{t}$ ("topponium") or $T\bar{T}$ ("topped-baryonium"), respectively. If it is found with the mass lying between these typical masses, it may be taken as a mixture of subquark-antisubquark pairs and quark-antiquark pairs, *etc.*

Very recently, the ATLAS and CMS Collaboration experiments at the CERN Large Hadron Collider have almost excluded the two ranges for the Higgs boson mass: the one lower than 114 *GeV* and the other between 141 *GeV* and 476 *GeV* [8,9], which disagrees with both the prediction in the unified quark-lepton model of the Nambu-Jona-Lasinio type [4] and that in the unified baryon-lepton model of the Nambu-Jona-Lasinio type [7]. Instead, the prediction in the unified subquark model [4] (92.8 $GeV \le m_H \le 131\ GeV$) shows a right ballpark on which the mass of the Higgs boson in the standard model should land. Moreover, the fact that the experimental values of m_H=125-126 *GeV* recently found by the ATLAS and CMS Collaborations are very close to the predicted one of $m_H = 2\sqrt{6}m_W/3 = 131\ GeV$ seems to strongly suggest that either m_{w_1}/m_{w_2} or m_{w_2}/m_{w_1} vanishes. It seems to indicate that the Higgs boson is a composite of the isodoublet spinor subquark-antisubquark pairs well described by the minimal unified subquark model with either one of subquark masses vanishing. Let us hope that the future LHC experiments will tell us whether the minimal unified subquark model is a viable model of all fundamental particles and forces!

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БОЗОН ХІГГСА В МІНІМАЛЬНО УНІФІКОВАНІЙ МОДЕЛІ СУБКВАРКА

В мінімальній субкварковій об'єднаній моделі всіх фундаментальних частинок і сил маса бозона Хіггса (m_H) в стандартній моделі електрослабкої взаємодії, за прогнозами, складе близько $2m_W\sqrt{6}/3$ (де m_W - маса зарядженого слабкого бозона), так що m_H = 131 *ГеВ* для m_W = 80,4 *ГеВ*, до якої експериментальні значення 125-126 *ГеВ*, нещодавно знайдені в співпраці ATLAS і CMS на LHC, дуже близькі.

Ключові слова: елементарні частинки, бозон Хіггса.

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БОЗОН ХИГГСА В МИНИМАЛЬНО УНИФИЦИРОВАННОЙ МОДЕЛИ СУБКВАРКА

В минимальной объединенной субкварковой модели всех фундаментальных частиц и сил масса бозона Хиггса (m_H) в стандартной модели электрослабого взаимодействия, по прогнозам, составит около $2m_W\sqrt{6}/3$ (где m_W - масса заряженного слабого бозона), так что m_H = 131 *ГэВ* для m_W = 80,4 ГэВ, к которой экспериментальные значения 125-126 ГэВ, недавно найденные в сотрудничестве ATLAS и CMS на LHC, очень близки.

Ключевые слова: элементарные частицы, бозон Хиггса.