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Семинар
"ТЕОРИЯ АДРОННОГО ВЕЩЕСТВА ПРИ ЭКСТРЕМАЛЬНЫХ УСЛОВИЯХ"

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Nambu sum rule in the NJL models: from superfluidity to top quark condensation

It may appear that the recently found resonance at 125 GeV is not the only Higgs boson. We point out the possibility that the Higgs bosons appear in models of top-quark condensation, where the masses of the bosonic excitations are related to the top quark mass by the sum rule similar to the Nambu sum rule of the NJL models. This rule was originally considered by Nambu for superfluid $^3\text{He-B}$ and for the BCS model of superconductivity. It relates the two masses of bosonic excitations existing in each channel of Cooper pairing to the fermion mass. An example of the Nambu partners is provided by the amplitude and the phase modes in the BCS model describing Cooper pairing in the s-wave channel. This sum rule suggests the existence of the Nambu partners for the 125 GeV Higgs boson. Their masses can be predicted by the Nambu sum rule under certain circumstances. For example, if there are only two states in the given channel, the mass of the Nambu partner is ~ 325 GeV. They together satisfy the Nambu sum rule $M_1^2 + M_2^2 = 4M_t^2$, where $M_t \sim 174$ GeV is the mass of the top quark. If there are two doubly degenerated states, then the second mass is ~ 210 GeV. In this case the Nambu sum rule is $2M_1^2 + 2M_2^2 = 4M_t^2$. In addition, the properties of the Higgs modes in superfluid $^3\text{He-A}$, where the symmetry breaking is similar to that of the Standard Model of particle physics, suggest the existence of two electrically charged Higgs particles with masses around 245 GeV, which together also obey the Nambu sum rule $M_+^2 + M_-^2 = 4M_t^2$.

Based on the papers: arXiv:1302.2360 by G.E.Volovik, M.A.Zubkov,
and arXiv:1301.6971 by M.A.Zubkov.

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