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9 The New LHC-Peak is a Bound State of 6 Top + 6 Anti top

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Abstract. The point of the present talk was that the at the time of the talk still statistically significant digamma resonance F(750) observed in ATLAS and CMS should be identified with the bound state of 6 top and 6 anti top quarks, which we have long speculated to exist. Since then my calculations have suggested that the mass of the bound state is indeed in the range about 750 GeV[1,2]. If the story would be supported by there exisiting a resonance into one of our suggested channels $\gamma\gamma$, pair of weak vector bosons, Higgs+ Higgs, or t + $\bar{t}$, ...with a mass in the neighbourhood of 750 GeV, then it would be an indication of the truth of our suggested new law of nature called "Multiple Point Principle". As a proposal it is not really new since we used it even in the 90's to PREdict the mass of the Higgs long before it were found to 135 $\pm$ 10 GeV. But it is "new" in the sense that yet nobody believes in it. It says that there are several vacua - in Standard Model case 3 - all having same energy density.

Povzetek. Avtor pojasnjuje domnevno izmerjen dogodek resonance pri 750 GeV z razpadom vezanega stanja dvanajstih kvarkov — 6 t in 6 $\bar{t}$ v dva fotona — ki ga je skupaj s sodelavci v modelu "Multiple Point Principle" napovedal prav v tem energijskem območju že dolgo pred meritvami [1,2]. Poleg razpada v dva fotona so napovedali razpade v pare dveh težkih in dveh skalarnih bozonov, v t in $\bar{t}$,... Z modelom "Multiple Point Principle" so že dolgo pred meritvijo mase higgsa napovedali njegovo maso pri (135 $\pm$ 10) GeV. Model "Multiple Point Principle" predpostavi, da eksistirajo različna vakuumska stanja, vsa z isto energijsko gostoto, *standardni model* pa velja do Planckove energije. (V času predavanja so meritve veljale kot statistično sprejemljive, nove meritve pa obstoja tega dogodka niso potrdile.)

9.1 Introduction

The main point of the talk were, when I gave it in July 2016 that the - at that time still statistically promising - *New Diphoton Resonance F(750) of Mass 750 GeV should be interpreted as a 6 Top + 6 Anti top Bound state* is by now so much worth in as far as the resonance F(750) now seem to have been washed out so that there is no more statistical evidence for it.

We long worked on a picture based on the *Standard Model alone*, but involving a bound state of 6 top + 6 antitop quarks bound by Higgs exchange and helped by

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gluon exchange. Thus at first it would seem that the whole content of the article broke down when the statistics of the digamma-spectrum improved and turned out no longer to support significantly any resonance any more.

However, let us immediately review that calculations[1,2] done partly after the finishing of the Bled-workshop estimated in remarkable well coinciding methods using our multiple point principle to be discussed plus a kind of bag model, that a consistent mass just close to 770 GeV is called for. Let me also give the hope of pointing to a newer statistical fluctuation[4] in the maas spectrum for two vector boson ZV via two two hadron jets and a lepton pair, though only seen in CMS with a mass 650 GeV. (With the accuracy, with which we may so far estimate the mass of our bound state of 6 top + 6 anti top, there is no difference between 750 GeV and 650 GeV, but the experimental accuracy is good enough that the experimentally you can NOT identify 650 GeV with 750 GeV)

9.2 Plan for article

The Main Content of Talk on the Diphoton being the 6 top + 6 antitop Bound State is:

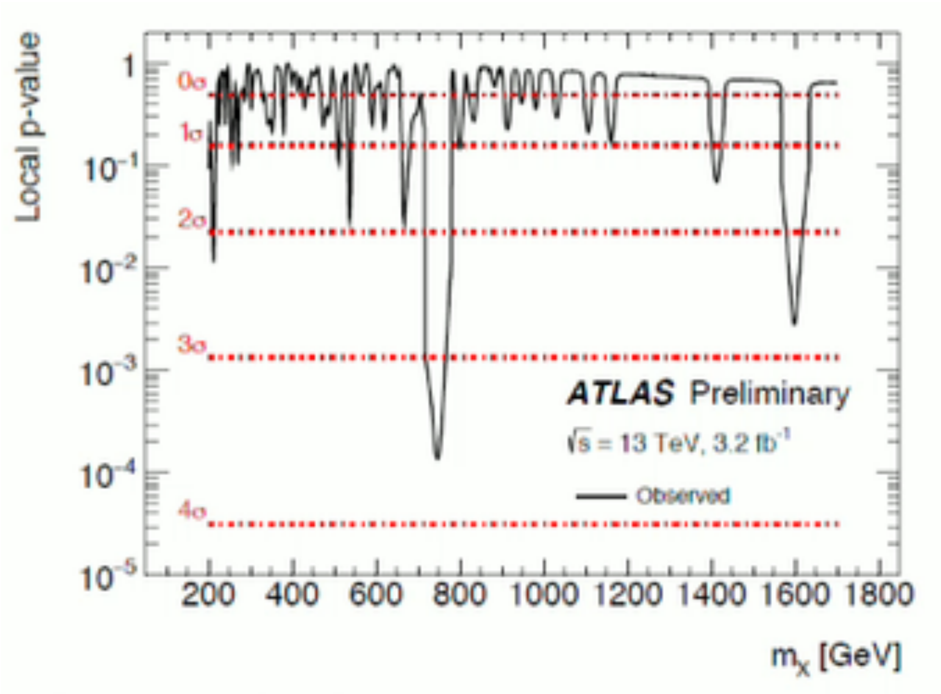
- In this scenario it is possible/natural, that the diphoton resonance of mass 750 GeV has not yet been seen in other channels; but it is very close, and at the $\sqrt{s} = 13$TeV soon to be investigated it can no longer be hidden, if we are right!
- Laperashvili, Das and I calculated a little correction to the observed Higgs mass relative to the one connected to the effective Higgs potential $V_{eff}(\phi_H)$. By an appropriate mass (and radius) of this bound state "diphoton"- particle the observed Higgs mass of 125 GeV could be just compatible with the high Higgs-field vacuum having just the same energy density as the present/physical vacuum, in which we live. Fitting the mass of the bound state to this only barely instability of vacuum leads to a mass compatible with 750 GeV!
- We (thus) suggest that there is new law of nature the Multiple Point Principle saying that there are several vacua with essentially zero energy density (to the accuracy meant here the three quarters of the energy density of the universe today is considered "zero").

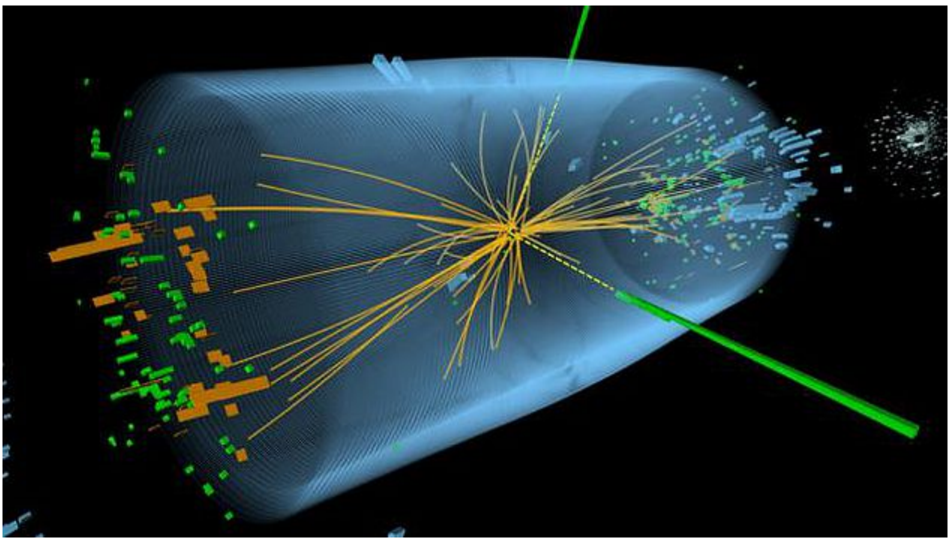
Plan of Talk on "New Resonance ?":

- Intro: Introduction about main thesis: New Particle is Bound State of 6 top + 6 antitop.
- New: Reviewing a bit doubtful peaks from recent LHC experiments.
- 12 tops: Froggatt's and mine crude estimates of the decay and production of our speculated bound state.
- MPP: Our long proposed new law of nature of several degenerate vacua.
- MPP mass: Our calculations using MPP to get mass predictions for the new peak, and for Higgs itself.
- Conclusion: Conclude, that you ought to believe in our long proposed but otherwise new law of nature, MPP (="Multiple Point Principle").

9.3 New Particle or Statistical Fluctuations?

The quite new particle - December 2015 - was a seemingly *new particle* , which decays into two photons and has a mass 750 GeV/c^2 just found at ATLAS and also seen by CMS. But which unfortunately got washed out in august 2016. We shall interprete it as a bound state of 6 top + 6 anti top quark, but nobody knows at present, what kind of particle it would be even, if it were not a statistical fluctuation.

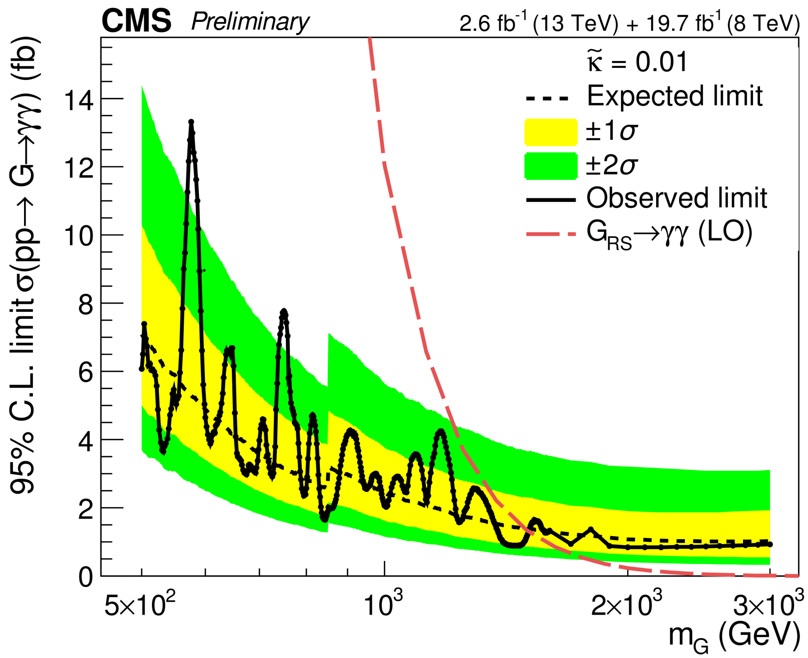




9.3.1 There are a couple of further presumably fluctuations or resonances?

The newest and most trustworthy deviation from the Standard Model - but nevertheless probably just a statistical fluctuation - is a little top/excess in the number of pairs of photons that comes out of the LHC collisions, when this number is plotted versus the collected mass of the two photons.

The mass of the peak is 750 GeV/c^2.



9.3.2 Has LHC shown anything in excess of the Standard Model ?

Not convincing, But there are Statistical Fluctuations, or is it New Physics ???

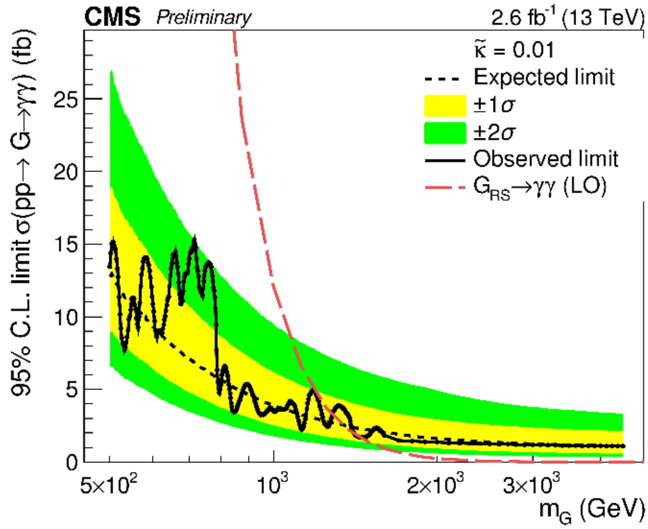
A couple of may be new physics observations

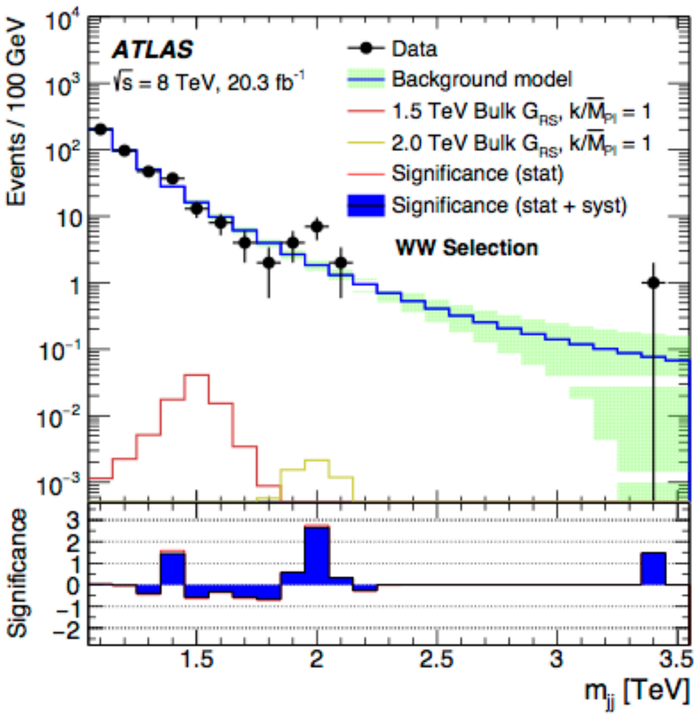
- **A Resonance with mass 1.8 TeV to 2 TeV** ca. 3 σ
- **A Resonance (or something else) Decaying into e.g. two Higgs bosons of W's ...** It is a single bin with an exceptional high number of events at a bit under 0.3 TeV in mass. It is for decay to two particles that could be Higgs's or W's or Z's This particle could easily be the particle which Colin Froggatt and I imagined as a bound state consisting of 6 top + 6 antitop quarks. (but now we shifted our hope to the 750 GeV excess)

9.4 An early Deviation from Standard Model

- **A excess of Higgs decay to $\gamma\gamma$ at ATLAS** The first deviation found from Standard Model was that ATLAS found a bit higher number of Higgs decays to two photons than predicted from Standard Model But CMS did not confirm that.

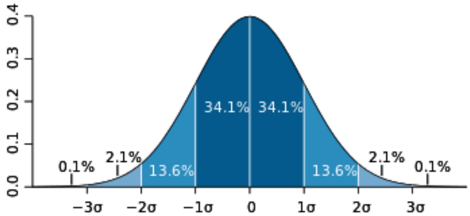
- The very newest is a resonance $\to \gamma\gamma$ with mass 750 to 760 GeV.



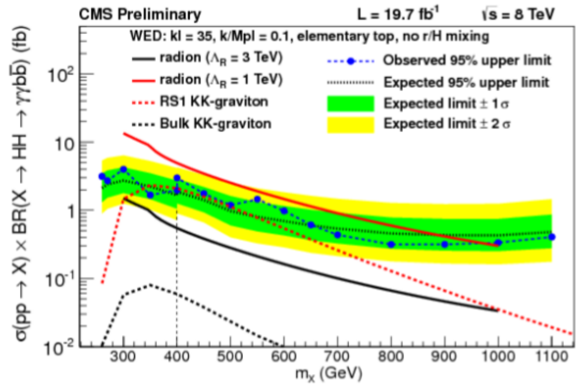


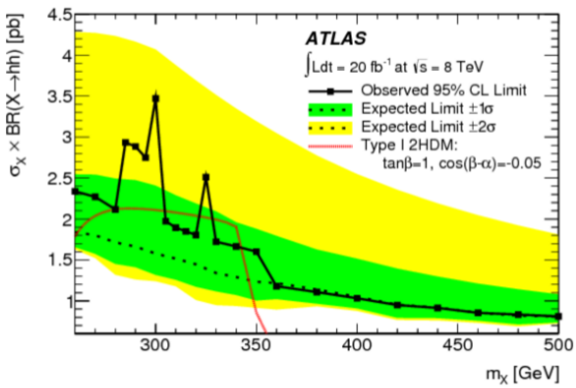
This Atlas plot shows the mass spectrum for pairs of particles WW, WZ or ZZ.

If the little relative increase in the number of events - i.e. of numbers of WW, WZ, or ZZ pairs - at 1.8 TeV were statistically significant. But it is only 3 standard deviations. Our/my ? hope is that we can identify this 1.8 TeV heavy peak as a resonance in two of the 750 GeV ones, but this may be too early to talk about now. We have calculated more on the 750 GeV peaks so far.



In the following two one look for the collective mass but seek to look for decays into two Higgses $b\bar{b}$ and to $\gamma\gamma$.





If you want to illustrate the main result of LHC that the Standard Model works perfectly almost one can show the two following not so easy to overview tabels just expressing that there are now good bounds for many theoretical hopes for new physics, and nothing seen so far. Typically the new physics scale of energy would have to be at least about 1 TeV, if it shall not be excluded already (see Figs. 9.1, 9.2).

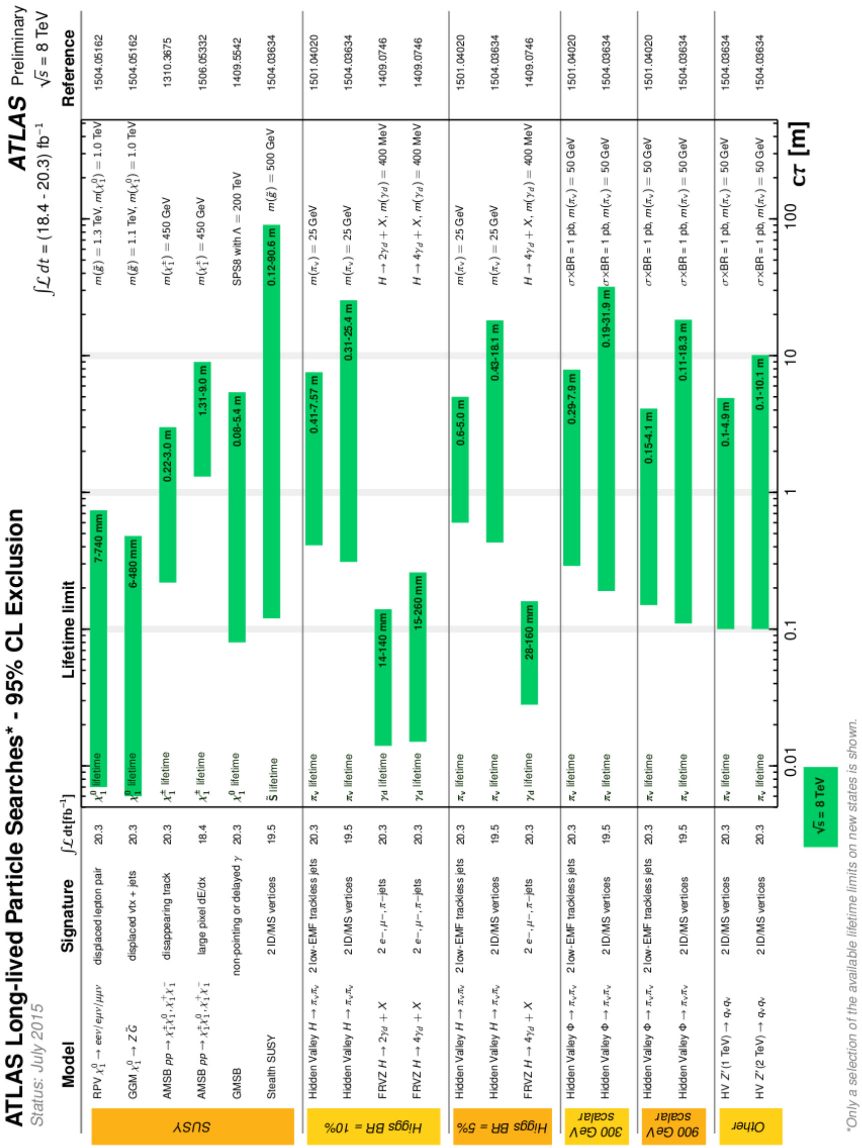


Fig. 9.1. ATLAS long-lived particle searches.

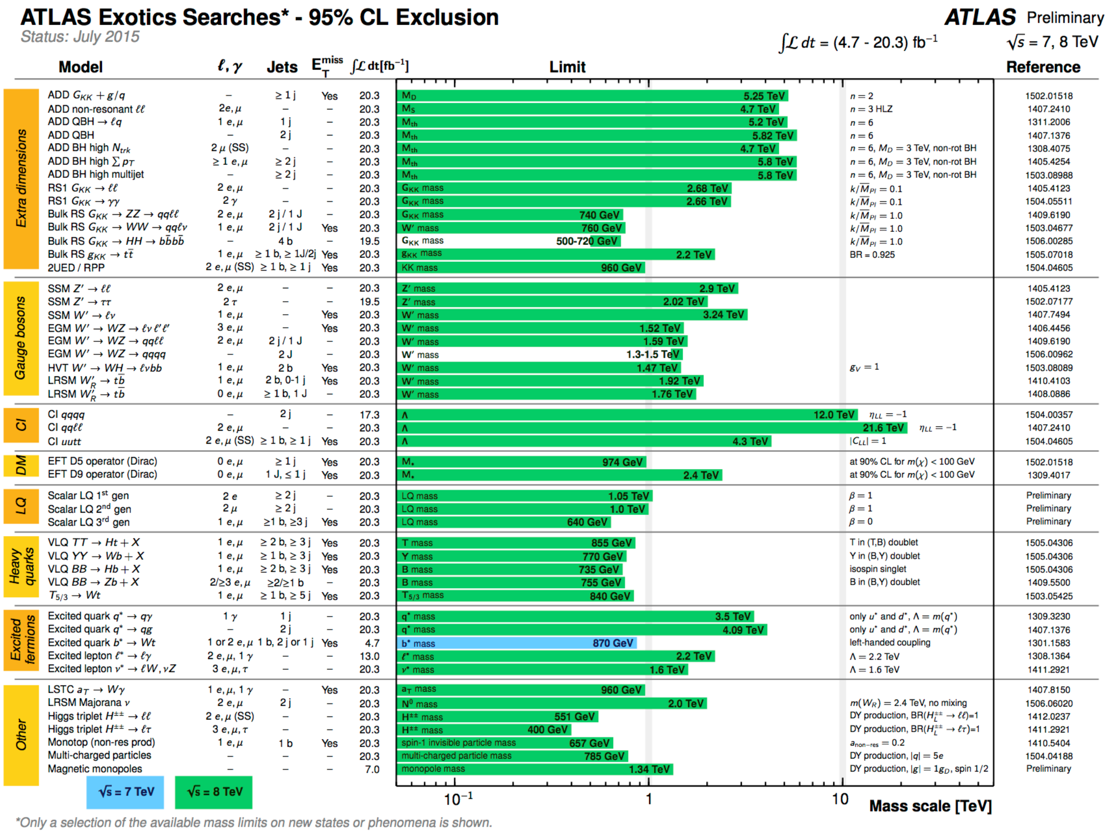
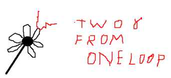
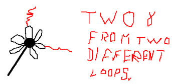


Fig. 9.2. ATLAS exotics searches.

9.5 12 tops

Colin Froggatt and I did an attempt to estimate the relative rates of decay of our hypothesised bound state of the 6 top and 6 anti tops. We assume as reasonable that the dominant decays are the two-particle decays because they have the best phase space. [1] Nevertheless of course all the tops and anti tops have to annihilate away before the bound state disappears. So with a low number, 2, of decay product particles compared to the number 12 of constituents, most of the top anti top pairs have to annihilate into nothing so to speak. a major new point of Froggatts and mine work is the division of the decay amplitudes into two slightly different types of decay: The two final state particles can come from the same top anti top annihilation, which we call “From same top-loop”, or they can be emitted from two different annihilating top anti top pairs, and the latter we call “ From TWO different loops of tops”. A major point to have in mind is, that, if the decay particles have some quantum numbers, then that quantum number has to be transfered from one annihilation loop to another one. The difference between these two cases is illustrated by the figures with the “flowers” on. One effect that could have been important is that e.g. weak gauge bosons W and the $SU(2)$ coupling superposition of the photon and the Z^0 have a weak gauge charge, which is conserved as long as the Higgs vacuum expectation value is not included in the considered diagram. That means that the Higgs expectation value or some exchange of the quantum number from one annihilation loop to another one is required in order for say WW decay occurring by use of the “From TWO different loops of tops” type of diagram. The major part of the photon which couples via the U(1) part, however, has no such “charge”. The main part of the $\gamma\gamma$ decay should therefore without any problem be possible with each photon coming from a different annihilation loop. Since there are 12/2 = 6 annihilation loops this a priori gives the main part of the (di)photon decay amplitude an extra factor 6; but it is even so that the number of loops that must annihilate into quite nothing is 5 for both particles going from one loop while only 4 in the case of the two decay particles coming from different loops.

From same top-loop: 

From TWO different loops of tops: 

Photon and transverse Z. The electric charge of the top quark is $q = 2e/3$ and the effective coupling for of the photon to the $t\bar{t}$ loop is $4\alpha/9$.
The corresponding effective coupling of Z to the $t\bar{t}$ loop is

$$\frac{\alpha}{2\sin^2\theta_W\cos^2\theta_W}\left[\left(\frac{1}{2}-\frac{2}{3}\sin^2\theta_W\right)^2+\left(-\frac{2}{3}\sin^2\theta_W\right)^2\right]=\frac{4\alpha}{9}*0.92. \tag{9.1}$$

We take $\alpha = 1/129$ and the Weinberg angle to be given by $\sin^2\theta_W = 0.23$.

[1] I thank Li for discussions at CERN long time ago where we especially discussed that the two-particle decays at the end tended to dominate.

Final st. f	Bound	Relative prediction	$\frac{\Gamma(S\to f)}{\Gamma(S\to\gamma\gamma)}$	Comt.
$\gamma\gamma$	$< 0.8(r/5)$	$(4\alpha/9)^2 = 1.2 * 10^{-5}$	1	
gl + gl	$< 1300 \cdot \frac{r}{5}$	$8\alpha_s/6)^2 = 2.3 * 10^{-3}$	190	
H + H	$< 20(r/5)$	$\alpha_h^2/4 = 3 * 10^{-4}$	25	Higgs
ZZ	$< 6(r/5)$	$\alpha_h^2/4 = 3 * 10^{-4}$	25	longtl.
WW	$< 20(r/5)$	$\alpha_h^2/2 = 6 * 10^{-4}$	50	longtl.
$Z\gamma$	$< 2(r/5)$	$2(4\alpha/9)^2 * 0.92$	1.8	
ZZ	$< 6(r/5)$	$(4\alpha/9)^2 * (0.92)^2$	0.8	tran.
WW	$< 20(r/5)$	$2(0.54\alpha)^2 = 3.5 * 10^{-5}$	3	tran.
$t + \bar{t}$	$< 300(r/5)$	$3\alpha_{t\bar{t}}^2 T_2 = 6.5 * 10^{-5}$	5	
		$\Gamma_{total}(S)/\Gamma(S \to \gamma\gamma)$:	302	

Table 9.1. Assuming dominance of *one* top anti top pair giving the final state, relative predictions are given for the partial decay widths of S and for the branching ratios relative to the diphoton decay width compared to the experimental upper bounds.

Gluon. The vertex for a gluon of color i coupling to a top quark is $g_s\lambda^i/2$. Averaging over the colors of the top quark, the effective coupling of the gluon to the $t\bar{t}$ loop becomes

$$\frac{\alpha_s}{3}\mathrm{Tr}\left(\frac{\lambda^i}{2}\right)^2 = \frac{\alpha_s}{6}. \tag{9.2}$$

We take $\alpha_s = 0.1$ and then sum over the 8 color states of the gluon.

Higgs and longitudinal $W^\pm$ and Z^0. According to the Goldstone Boson Equivalence Theorem in the high energy limit the couplings of the longitudinal $W^\pm$ and Z^0 become equal to those of the corresponding eaten Higgs fields. The Higgs field coupling to the $t\bar{t}$ loop is

$$\alpha_h = \frac{g_t^2/2}{4\pi} = 0.035 \tag{9.3}$$

where g_t is the top quark Yukawa coupling constant.

Transverse $W^\pm$. The $W^\pm$ gauge fields are formed from two real fields, W_1 and W_2, lying in the adjoint representation of SU(2). So their effective coupling to the $t\bar{t}$ loop is

$$\frac{1}{2} * \frac{\alpha}{\sin^2\theta_W}\left(\left(\frac{\sigma^i}{2}\right)^2\right)_{t_L t_L} = \frac{\alpha}{8\sin^2\theta_W} = 0.54\alpha, \tag{9.4}$$

where the extra factor of $1/2$ is due to $W^\pm$ only interacting with left-handed top quarks. The final sum over $i = 1, 2$ gives a factor of 2 in the decay rate.

Photon and transverse Z. The hypercharge coupled superposition of the photon and Z^0 is described by the field $B_\mu = \cos\theta_W A_\mu - \sin\theta_W Z_\mu$. It couples with an average squared charge $[(2/3)^2 + (1/6)^2]/2 = 0.236$ to a top quark. The two loop diphoton decay is dominated by the production of this B_μ component and so the effective coupling for the photon is 0.236α.
The corresponding effective coupling of Z is $0.236\alpha\tan\theta_W$.

Fin. f	Bound	Relative pred.	$\frac{\Gamma(S\to f)}{\Gamma(S\to\gamma\gamma)}$	Com.
$\gamma\gamma$	$< 0.8(r/5)$	$(0.236\alpha)^2 = 3.35 * 10^{-6}$	1	
gl + gl	$< 1300 \cdot \frac{r}{5}$	$8(\alpha_s/18)^2 = 2.5 * 10^{-4}$	74	
H + H	$< 20(r/5)$	$\alpha_h^4/(4T_2) = 3.4 * 10^{-5}$	10	Higgs
ZZ	$< 6(r/5)$	$\alpha_h^4/(4T_2) = 3.4 * 10^{-5}$	10	longtn.
WW	$< 20(r/5)$	$\alpha_h^4/(2T_2) = 6.8 * 10^{-5}$	20	longtn.
$Z\gamma$	$< 2(r/5)$	$2(0.236\alpha)^2 \tan^2\theta_W$	0.6	
ZZ	$< 6(r/5)$	$(0.236\alpha)^2 \tan^2\theta_W$	0.09	transv.
WW	$< 20(r/5)$	$2(0.54\alpha)^4/T_2 = 6 * 10^{-8}$	0.02	transv.
$t + \bar{t}$	$< 300(r/5)$	$3\alpha_{t\bar{t}}^4/T_2 = 1.06 * 10^{-3}$	316	
		$\Gamma_{total}(S)/\Gamma(S\to\gamma\gamma)$:	432	

Table 9.2. Assuming dominance of *two* top anti top pairs giving the final state, relative predictions are given for the partial decay widths of S and for the branching ratios relative to the diphoton decay width compared to the experimental upper bounds(Franceschini).

Gluon. Averaging over the colors of the two (anti)top pairs, the effective coupling of a gluon of color i for the "crossed" diagram is

$$\frac{\alpha_s}{9}\mathrm{Tr}\left(\frac{\lambda^i}{2}\right)^2 = \frac{\alpha_s}{18}. \tag{9.5}$$

Higgs, longitudinal Z^0, $W^{\pm}$, top antitop. We use the same effective couplings as in the one loop case.

Final state f	Bound	$\frac{\Gamma(S\to f)}{\Gamma(S\to\gamma\gamma)}$	Comment
$\gamma\gamma$	$< 0.8(r/5)$	1	
gluon + gluon	$< 1300(r/5)$	117	
Higgs + Higgs	$< 20(r/5)$	15	Higgs-particles
ZZ	$< 6(r/5)$	15	longitudinal
WW	$< 20(r/5)$	30	longitudinal
$Z\gamma$	$< 2(r/5)$	1.0	
ZZ	$< 6(r/5)$	0.3	transverse
WW	$< 20(r/5)$	1.1	transverse
top + anti top	$< 300(r/5)$	208	
	$\Gamma_{total}(S)/\Gamma(S\to\gamma\gamma)$:	387	

Table 9.3. Benchmark model with $\epsilon^2 = 0.15$. Predictions are given for the decay branching ratios of S relative to the diphoton decay width and compared to the experimental upper bounds from ref. [5].

9.5.1 Production

We assume the production rate to be of an order calculated analogous to the production of a fourth family just taking into account that our bound state consist of 12 quarks. Using our decay ratio estimates the rate for $S \to \gamma\gamma$ is order of magnitude o.k.

9.6 MPP

Multiple Point Principle In general, a quantum field theory allows an existence of several minima of the effective potential, which is a function of a scalar field.

If all vacua, corresponding to these minima, are degenerate, having zero cosmological constants, then we can speak about the existence of *a multiple critical point (MCP) in the phase diagram*. See:[7].

We postulated a Multiple Point Principle (MPP) for many degenerate vacua. This principle should solve the finetuning problem by actually making a rule for finetuning.

9.6.1 Multiple Point Principle

The Multiple Point Model (MPM) of the Universe evokes simply the Standard Model up to the scale $\sim 10^{18}$ GeV.

If the MPP is very accurate, we may have a new law of Nature, that can help us to restrict coupling constants from theoretical principles.

Assuming the existence of two degenerate vacua in the SM:

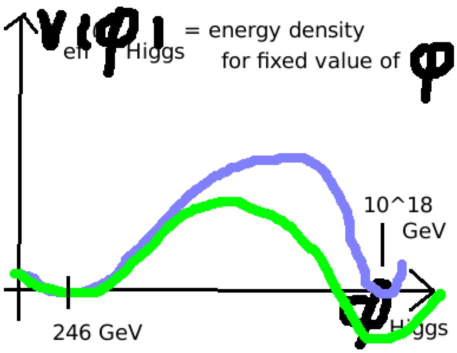
1. the Electroweak vacuum at $\nu = 246$ GeV, and
2. the Planck scale vacuum at $\nu_2 \simeq 10^{18}$ GeV,

See [8].

We predicted the top-quark and Higgs boson masses:

$$M_t = 173 \pm 5 \text{ GeV}, \; M_H = 135 \pm 9 \text{ GeV}.$$

Multiple Point Principle



Here it is shown the existence of the second (non-standard) minimum of the effective potential of the pure SM at the Planck scale. Multiple Point Principle: The tree-level Higgs potential with the standard "Electroweak minimum" at $\phi_{min\ 1} = \nu$ is given by:

$$V_1 = \frac{\lambda}{4}\left(\phi^2 - \nu\right)^2 + C_1 .$$

The new minimum at the Planck scale:

$$V_2 = V_{eff}(\text{at Planck scale}) = \frac{\lambda_{run}}{4}\left(\phi^2 - \nu_2\right)^2 + C_2,$$

can be higher or lower than the Electroweak one, showing a stable Electroweak vacuum (in the first case), or metastable one (in the second case).

In accordance with cosmological measurements, Froggatt and Nielsen assumed that cosmological constants C_1 and C_2 for both vacua are equal to zero (or approximately zero): $C_{1,\,2} = 0$, or $C_{1,\,2} \approx 0$.

This means that vacua $\nu = \nu_1$ & ν_2, and they are degenerate. Multiple Point Principle The following requirements must be satisfied in order to, the effective potential have two degenerate minima:

$$V_{eff}(\phi^2_{min\ 1}) = V_{eff}(\phi^2_{min\ 2}) = 0,$$

and

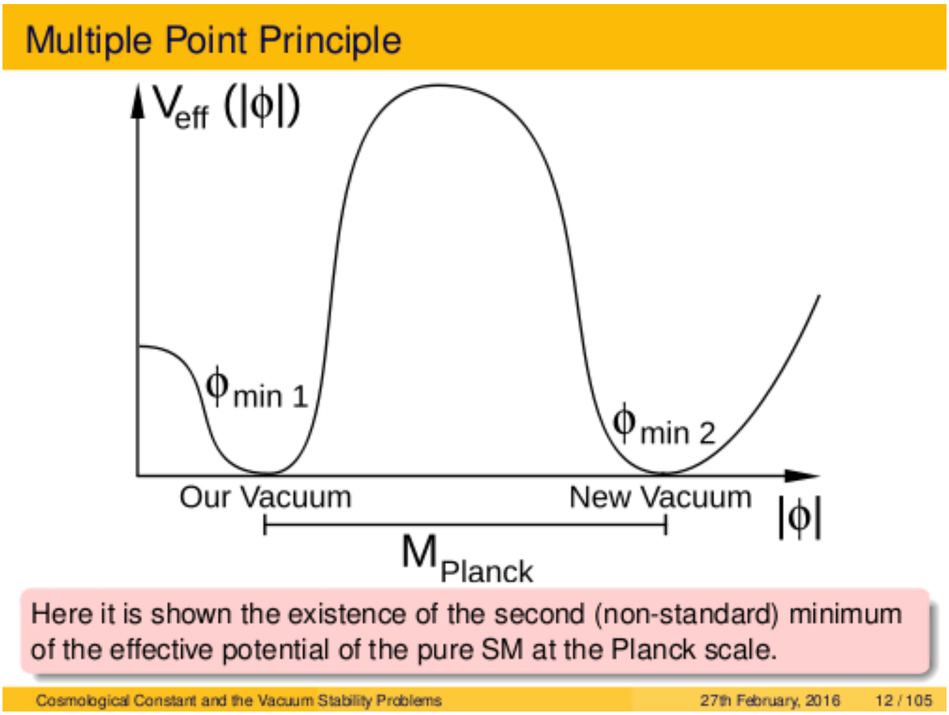
$$V'_{eff}(\phi^2_{min\ 1}) = V'_{eff}(\phi^2_{min\ 2}) = 0,$$

where,

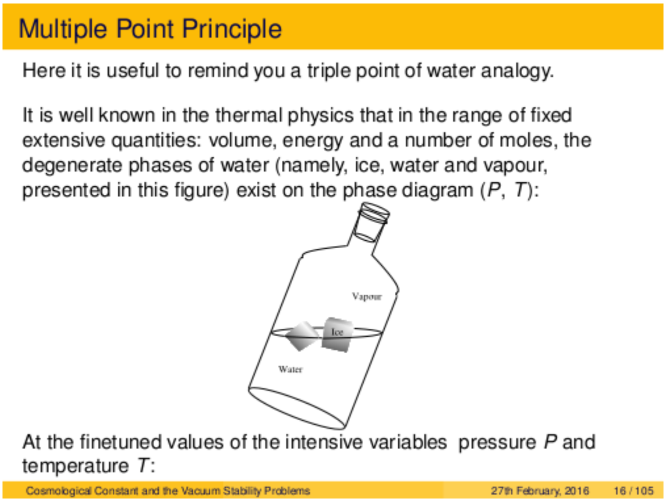
$$V'(\phi^2) = \frac{\partial V}{\partial \phi^2}$$

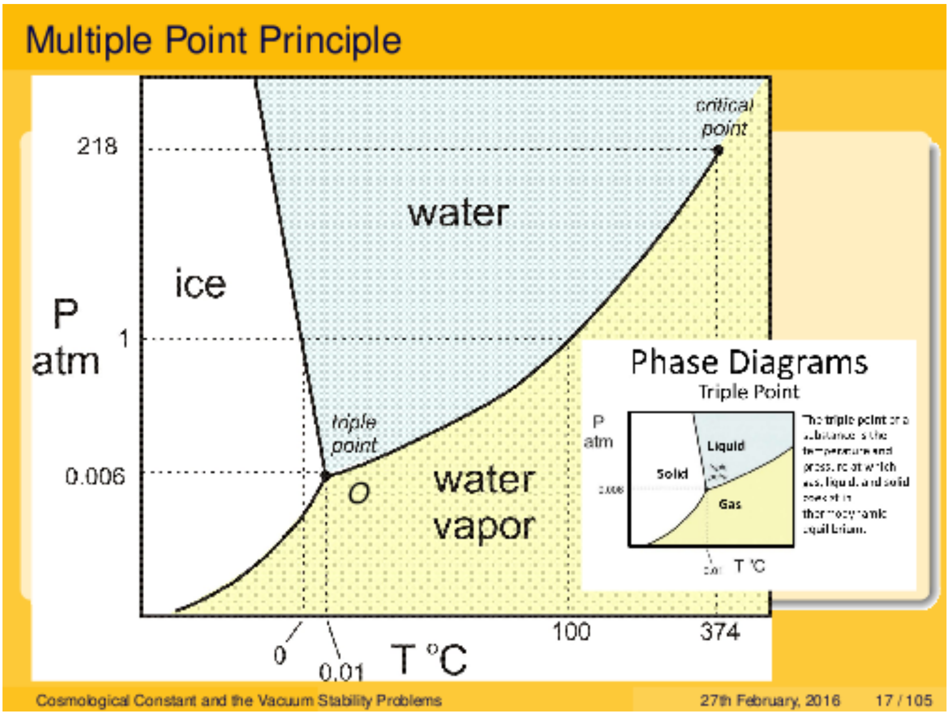
[6]

Multiple Point Principle postulates: There are many vacua with the same energy density, or cosmological constant, and all cosmological constants are zero, or approximately zero.



Multiple Point Principle If several vacua are degenerate, then the phase diagram contains a special point – the Multiple Critical Point (MCP), at which the corresponding phases assembly together.





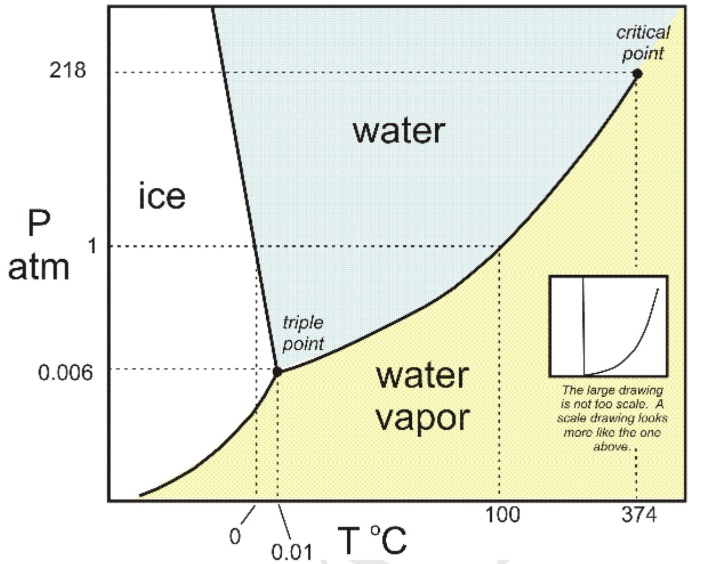


Fig. 5: The phase diagram (P, T) of water analogy. The triple point O with $T_c = 0.01^C$ and $P_c = 4.58\, mm\, Hg$ is shown in Fig. 4.

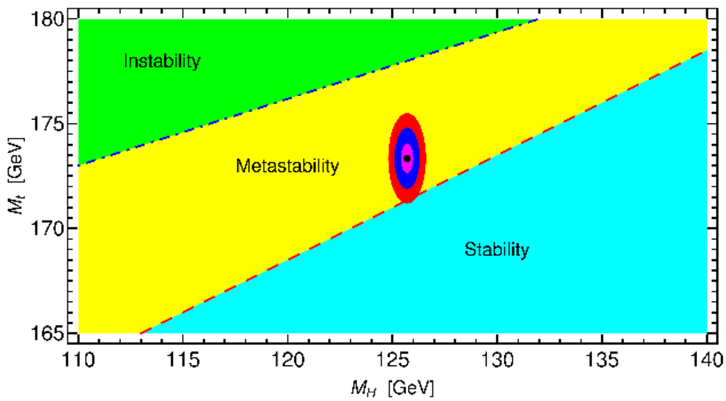


Fig. 6: Stability phase diagram (M_H, M_t) is divided into three different sectors: 1) an absolute stability region – blue region of figure; 2) a metastability (yellow) region, and 3) an instability (green) region. The black dot indicates current experimental values $M_H \simeq 125.7$ GeV and $M_t \simeq 173.34$ GeV. The ellipses take into account 1σ, 2σ and 3σ, according to the current experimental errors.

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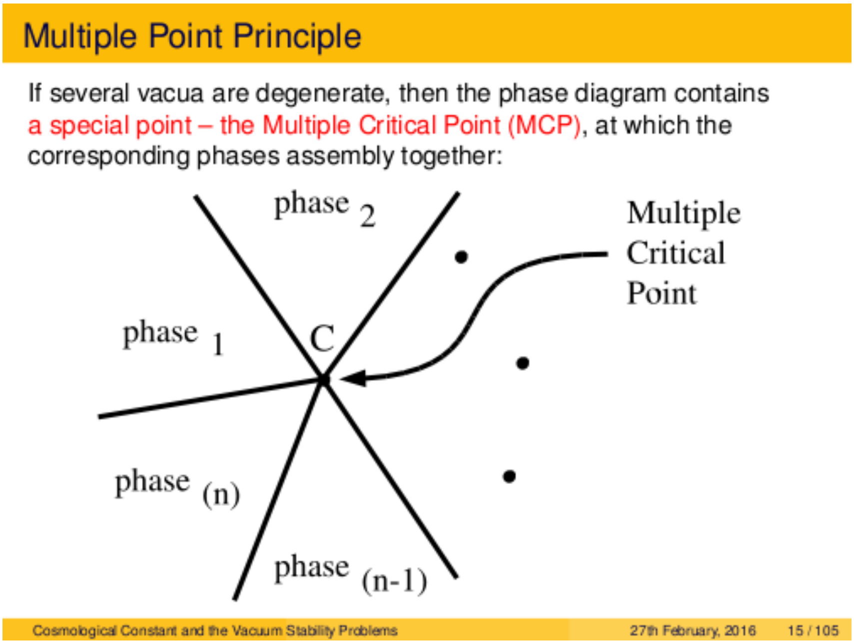
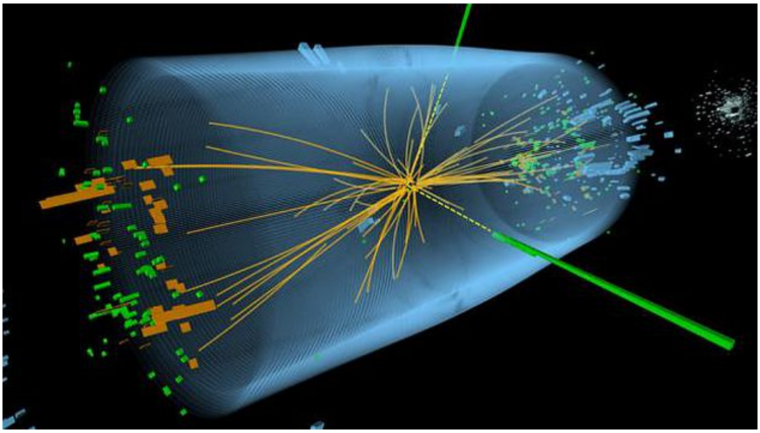
At the finetuned values of the variables pressure P and temperature T – we have:

$$T_c \approx 0.01^{\circ}C, \ P_c \approx 4.58 \text{ mm Hg},$$

giving the critical (triple) point O shown in the previous figure.

This is a triple point of water analogy. The idea of the Multiple Point Principle has its origin from the lattice investigations of gauge theories. In particular, Monte Carlo simulations of $U(1)$, $SU(2)$ and $SU(3)$ gauge theories on lattice, indicate the existence of the triple critical point.





9.7 MPPmass — Post/Pre- dicting Masses from Multiple Point Principle

9.7.1 Claim 3 Post or Pre-dictions of Masses from MPP

We use/assume three different “vacua” which we may name: “physical”, “Higg Higgs” and “S condensate”:

- 1.Mass of Higgs from degeneracy of "physical" and "High Higgs" **Prediction !**
- 2. Mass of the new resonance S of 750 GeV from degeneracy of "physical" and "Higgs Higgs" with improved accuracy. (postdiction only, but...)
- 3. Mass of the new 750 GeV resonance from degeneracy of "physical" and "S condensate".(now postdiction) (Actually Colin Froggatt and I made this calculation as PREdiction to 285 GeV for the mass, but without attaching much belief to it.)

kunstmaler lars andersen http://www.23.dk/skak.htm

Lars Andersen

Historiemaler Portrætmaler Provokunstner Om Lars Andersen CV/omtale Kontakt

"Skak" (Mogens Lykketofte og Holger Bech Nielsen)

Tilhører Frederiksborg Museet

Hænger i moderne samling i det Nationalhistoriske Museum på Frederiksborg Slot.

Bragt i årbogen "Dansk Kunst 1998", Jyllandsposten, Politiken, BT, Ud og Se,

Berlingske Tidende, Ekstra Bladet, Kristeligt Dagblad, Alt for Damerne.,

Frederiksborg Amts Avis, DR1, DR2, TV Lorry , Kunstavisen Billed Bladet....

Trykt som plakat 50x70 cm.

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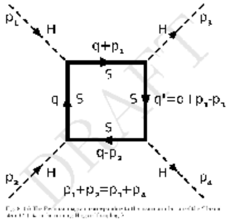
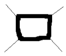
1 of 2 10/30/2012 12:47 PM

Higgs-Mass Correction:



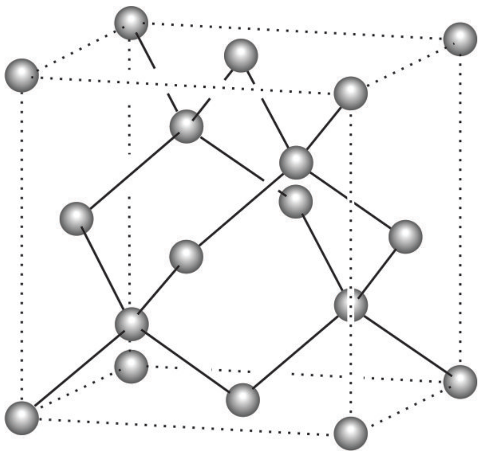
$$m_H^2 = 2(\delta\lambda + \lambda)v^2$$

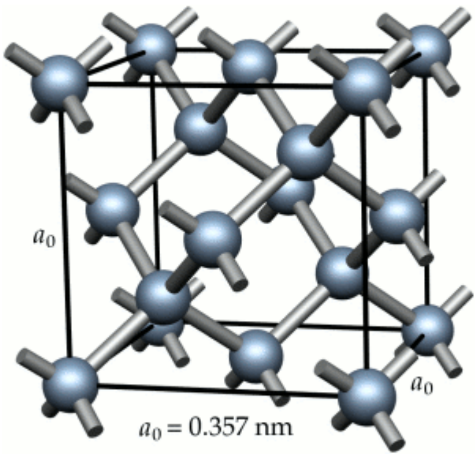
$\delta\lambda =$  $+ \dots$

9.8 Getting the Bound state S Mass from Requiring Degeneracy of Vacua "Physical" and "S Condensate" to 4 m_t

With the right not so obvious approximations one gets in a very simple way that the bound state S shall have the mass $m_S = 12m_t/3 = 4m_t$. Thes assumptions:

- The "S condensate" vacuum is a lattice of same structure as diamond crystal.
- We can count the binding energy as if the neighbouring S-states in the crystal have there constituent top and anti tops in the n=2 level of the surrounded S.
- We can ignore the effective Higgs mass for the exchange up to the n=2 level, but from n=3 and on the Higgs mass may be taken infinite.
- The MPP - degeneracy of "physical" and "S condensate" vacua - requires the binding in the crystal to just cancel the Einstein masses of the S particles.
- We can take the S's in the "S condensate " vacuum as at rest.





9.8.1 Mass from MPP of S-condensate

We want to estimate the condition in a non-relativistic ansatz for the vacuum with the S-condensate as a diamond-structure pattern of S-bound states. The binding energy between the neighbours in this pattern is estimated by assuming that the four nearest neighbours S's to a certain S have their top and anti tops effectively filling up the 4 $n = 2$ states surrounding the S considered. Since $n = 2$ states in the Bohr atom have a binding $1/n^2 = 1/4$ times that in the $n = 1$ states, we take it that the binding per quark of a neighbouring S to a given one is in the Higgs mass zero approximation just 1/4 times that binding of one of the constituent quarks inside its S. Thus the binding of an S to its neighbour must be with a potential 1/4 of the binding energy of an S from its constituents.

In the assumed diamond lattice each carbon atom has 4 nearest neighbours, but each "binding-link" is attached to two carbon atoms. So the number of "binding-links" is twice as large as the number of carbon atoms. If we therefore as argued have one quarter of the binding energy in these "binding links" as in the S's or the carbon atoms in the analogue, there will be 2/4 = 1/2 as much binding in the "binding -links" as in the S's themselves.

If the Einstein energy $E = mc^2$ of a sample of bound states S consisting of top and anti tops shall be just compensated by the binding energy between these quarks, then the total binding energy per quark must add up to this Einstein energy numerically. Such compensation is required by our new law of nature "Multiple point principle".

If the bindings in the "binding-links" make up 1/2 of the binding of the constituents inside their respective S bound states, the latter must make up 2/3 of the Einstein energy. The a priori Einstein energy of the twelve top or anti top quarks in an S bound state is of course 12 m_t. The binding energy the S-bound state should thus from MPP be 12 m_t * 2/3. Thus the left over mass of the S bound state shall be 12 m_t - 2/3 *12m_t = 12/3 m_t = 4 m_t, which is indeed very close to the observed mass $m_S = 750\text{GeV}$. In fact $4m_t = 4 * 173\text{GeV} = 692\text{GeV}$.

9.9 Conclusion

Conclusion

- We have argued for that in our interpretation of the diphoton peak as a bound state of $6t + 6\bar{t}$ bound state there are two arguments using the "multiple point principle" that independently lead to the bound state having a mass near the 750 GeV:
  - A. The correction to the to be observed Higgs mass needed to make degeneracy (MPP) of the physical and the high Higgs vacua is close to requiring the bound state mass 760 GeV.
  - B. To have the degeneracy (MPP) of the S-condensate vacuum with the physical one an S mass of $\sim 4m_t$ is needed.
- Even ignoring the little correction from the bound state S to the relation between the Higgs mass and the energy density of the high Higgs vacuum is so well approximately in correspondance with the MPP-required degeneracy of the physical and the high higgs vacua that we - Colin Froggatt and I - PREdited the Higgs mass correctly within 10 GeV!
- That the 750 GeV peak is so far only seen in the diphoton channel is so far barely consistent with the bounds from LHC, because one has not yet analysed the other relevant channels at 13 TeV.
- The production rate is in crude agreement with our estimate.

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