# “On a Singular Solution in Higgs Field (5) -The degenerates into the candidates for dark matter and dark energy from ur-Higgs bosons”

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## Contents

We have recently discussed the mass, structure of SM Higgs boson ($H^0$), and also the relation between the calculated mass (120.611 GeV/$c^2$) and the latest results of LHC.

*In this paper, we'll treat with ;*

1. Brief review

Higgs mass correction with the mesons' masses of excited or resonant states:

- corrected Higgs mass (125.28 GeV/c2) formulae with the respective mass of excited states, and
- its multiwall-fullerene representation of glueballs, having ρ mesons inside, as an excited state of ur-Higgs boson (ur-$H^0$)



2. Degenerate into a candidate of dark matter

Almost ur-$H^0$ degenerates into the hybrid molecules of a glueball and pseudo-scalar mesons as a candidate of dark matter.

3. Degenerate into the candidate of dark energy

The ur-$H^0$ degenerates also into the quasi-crystals of fullerene consists of σ mesons and some ω mesons, as the candidate of dark energy, which will rise repulsive strong force.

4. Comparison to observations—in good accordance with;

- WMAP: content of matter, dark matter and dark energy
- Fermi-LAT: mass of dark matter



## == Brief review ==

***Higgs mass correction with the mesons' masses of excited or resonant states:***

- corrected Higgs mass formulae with the respective mass of excited states:

$$M_{(H^0)^*} \equiv \sum_{M_i}\left[3\chi_{c^0}(1p),\ \rho_3(1990)\overline{\rho_3}(1990)\ +4\left\{\left(B_S{}^*\overline{B}_S{}^*\right)\left(B_C{}^*\overline{B}_C{}^*\right)\left(D_S{}^{*+}D_S{}^{*-}\right)\right\}\right]$$

$$\cong 125.28\ \mathrm{GeV/c^2}.$$

- Its multiwall-fullerene representation of glueballs, having ρ mesons inside, as an excited state of the ur-$H^0$

$$M_{(H^0)^*} \equiv \sum_{M_i}\left[40\times f_6(3100)\right] \cong \sum_{M_i}\left[6\times\left\{\left(GB_{40}\right)+\rho(770)\right\}\right]$$

$$= \sum_{M_i}\left[6\times\left(GB_{40}\right)+3\rho(770)\overline{\rho}(770)\right].$$



## 2. Degenerate into the candidate of dark matter

### 2.1 *Transformation to excited $H^0$ from ur-$H^0$*

**The mass difference between them is**

$$\Delta m = 125.28 - 120.611 = 4.669\ \mathrm{GeV/c^2}.$$

**On the other hand, the energy of γ-ray from $(t\bar{t})^*$ was**

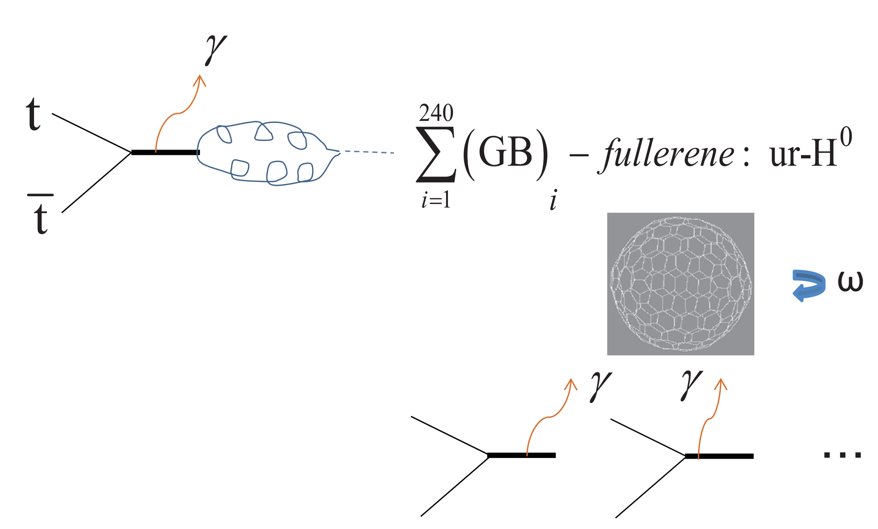
$$E_\gamma = 492.35\ \mathrm{MeV}.$$

**So the total number ($N_e$) of $(t\bar{t})^*$ decay reaction to ur-Higgs, corresponding to $\Delta m$ is**

$$N_e = \Delta m \cdot c^2 / E_\gamma = 9.483$$

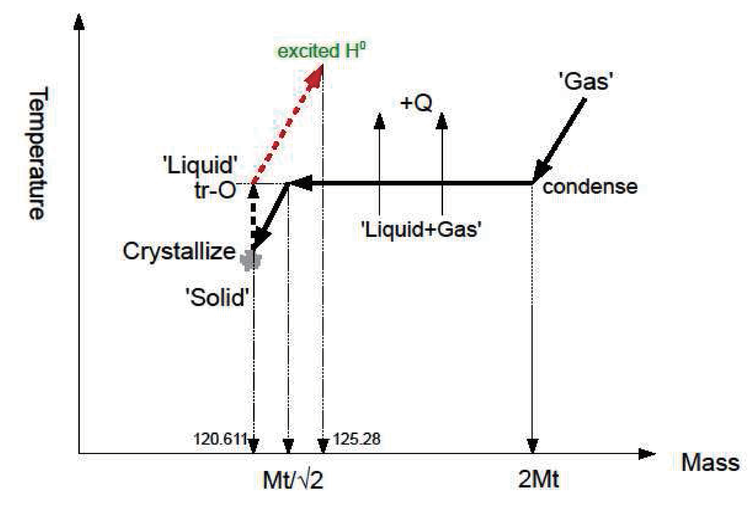


which means that only ($1/N_e$) of these ur-Higgs bosons can be transformed finally to the $H^0$ with corrected mass (125.28 GeV/$c^2$) through multi-photon resonances of its component by irradiated γ-rays from neighboring $(t\bar{t})^*$'s, onto $H^0$.






## Phase transition diagram -- from (tt_bar)* to Higgs boson






## To estimate the rate of Atom

We consider that *the rate of excited Higgs boson would be equivalent to the rate of Atom itself*. Then from *the phase transition diagram*, we compute the rate as

$$R_{(\mathrm{Atom})}{}' = \frac{1}{N_e}\times\left(1-\eta_{+Q}\right) = \frac{1}{N_e}\times\left(1-\frac{2M_t - M_t/\sqrt{2}}{2M_t}\right)$$

$$= \frac{1}{9.483}\left(\frac{1}{2\sqrt{2}}\right) = 0.03728,$$

whose value will be reviewed later.



### *2.2 Degenerate into a candidate of dark matter (DM) from ur-$H^0$*

The rate of 'total matter' is also estimated as

$$R_{(\text{total matter})}{}' = \left(1-\eta_{+Q}\right) = \frac{1}{2\sqrt{2}}.$$

Since the rate of fullerene of pure Glueballs (GBs) has been computed as *one third* of the 'total matter' which was represented by the mixture of fullerenes of pure GBs and the hybrid molecules (one-GB and several certain light pseudo-scalar mesons) in preceding paper, the rate of remainder is

$$\left(1-1/3\right)\times R_{(\text{total matter})}{}' = \frac{1}{3\sqrt{2}} = 0.2357 \equiv R_{(\mathrm{DM})}{}'$$

that is, the rate of degenerate into a candidate of DM from ur-$H^0$.



## 3. Degenerate into the candidate of dark energy

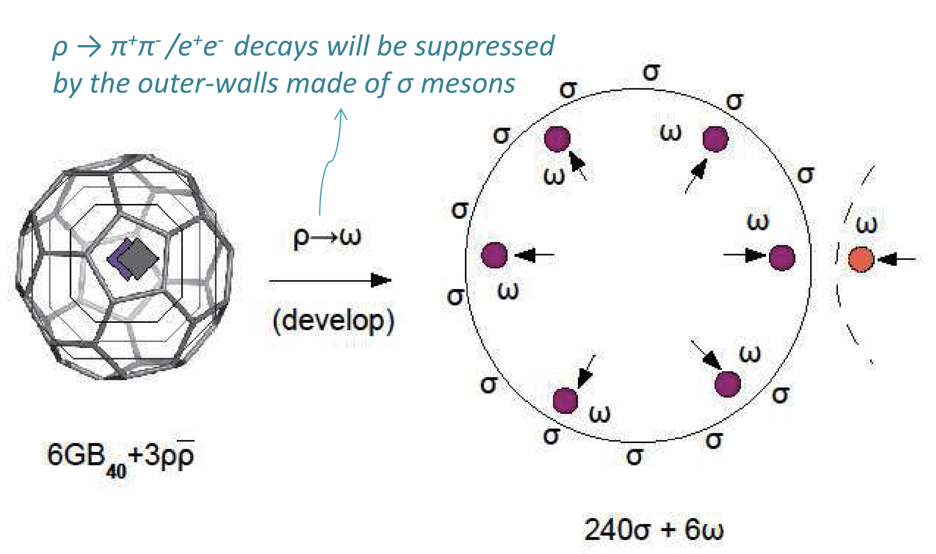
### 3.1 Formation of the quasi-crystals of fullerene consists of σ mesons and some ω mesons

We already reviewed multiwall-fullerene representation of glueballs, having ρ mesons inside, as an excited state of the ur-$H^0$. Here we study its degenerate into developed fullerene consists of GBs (σ mesons) and some ω mesons.

The ω mesons in developed fullerenes will raise repulsive strong force as soon as the (free) fullerenes approach very near (< 0.5 fm) each other as shown in Figure. Therefore we expect that these free fullerenes are to be the candidate of dark energy.



excited ur-$H^0$ of multi-wall developed fullerene






## Finite nucleus by mean-field theory of σ-ω model

$$\sigma = \sigma(r),\quad \omega_\mu = \delta_{\mu,0}\omega(r)$$

By inserting into Dirac equation.

$$\left(i\gamma_\mu\partial^\mu - m - U(r) - \gamma^0 V(r)\right)\psi(x) = 0,$$

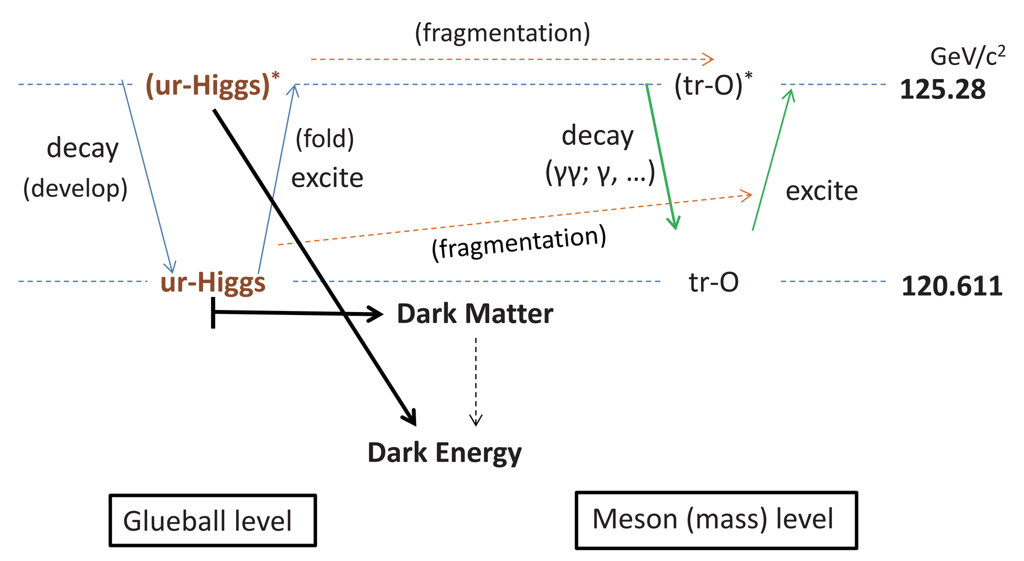
$$\text{where}\quad U(r) \equiv g_\sigma\sigma(r),\ V(r) \equiv g_\omega\omega(r).$$

We shall regard the developed fullerene as a 'finite nucleus of the limit of N(p, n)→0, namely, m(p, n)→0'.

*Because the masses of degenerate fullerenes are thus to be the effective mass which has been reduced by σ-potential, the removing speed by the repulsive force between their ω mesons would not be so small, overcoming the attractive force by σ mesons, after approaching very near each other.*



### Overview of degenerate ur-Higgs






### 3.2 The rate of the candidate of dark energy

So the rate of candidate of dark energy is computed by

$$R_{(\text{dark energy})}{}' = 1-\left(R_{(\mathrm{Atom})}{}' + R_{(\mathrm{DM})}{}'\right)$$

$$= 1-(0.03728+0.2357)$$

$$= 0.7270$$

*Here large amount of condensing (latent) heat from (tt_bar)* gas to the liquid (Higgs boson), in the phase transition diagram, might be considered as at last transformed to dark energy, by which the quasi-crystal would be annealed (or sublimated) to more developed fullerene.*



### 3.3 Re-calculation of the content ratios

*Although all rates of the candidates are obtained now, more over, we should refine these values as follows.*

In order to take account of mass contribution from QGP, such as *totally equivalent* top quark, we re-calculate the rate of Atom;

$$R_{(\mathrm{Atom})} \cong R_{(\mathrm{Atom})}{}' \times \frac{M_t + \left\{M_b + M_c + M_s + n^*(gluon)\right\}}{M_t}$$

$$\cong 0.03728\times\frac{171.266+\left\{4.65+1.275+0.095+137.036\times\left(0.50255/2\right)\right\}}{171.266}$$

$$= 0.04609,\quad \text{where we put } n^* \equiv 1/\alpha.$$

$$R_{(\mathrm{DM})} \equiv R_{(\mathrm{DM})}{}' = 0.2357,$$

$$\therefore\ R_{(\text{dark energy})} = 1-\left(R_{(\mathrm{Atom})} + R_{(\mathrm{DM})}\right) = 0.7182$$

all of which are completely in accordance with the result of WMAP (9 Years).



## 4. Comparison to observations

- WMAP: content of matter, dark matter and dark energy

| | Atom | Dark Matter | Dark Energy |
|---|---|---|---|
| WMAP (9 Years) | 0.0463 ± 0.0024 | 0.233 ± 0.023 | 0.721 ± 0.025 |
| This calculation | 0.04609 | 0.2357 | 0.7182 |

- **Fermi-LAT: mass of dark matter**

| Fermi-LAT | This calculation | |
|---|---|---|
| $129.8 \pm 2.4^{+7}_{-13}$ | ≈ 120.611 | GeV/$c^2$ |

And … **- CDMS-II WIMP mass: 8.6** GeV/$c^2$

$14\times$(WIMP mass) ≅ This calc. (**120.611**; possible ancestor of ***the WIMP mass***)