Thermal Phase Transition in the Gauge-Higgs Unification with 126 GeV Higgs (work in progress)

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Introduction

Sakhalov
1. B-violation
2. CP-violation
3. Out of thermal eq.

EWSB and Baryon Asymmetry
1st order -> Electroweak Baryogenesis
2nd order -> Other mechanisms (Leptogenesis, etc..)

1st or 2nd : It is a problem.

c.f.
SM: 2nd order or crossover
GHU[flat] : strong 1st ! Shiraishi, Ho-Hosotani, Maru-Takenaga, Panico-Serone

Formuration

GHU : Gauge Theory in 5D

$$\sum_{\text{KK mode } n} \sum_{\text{Matsubara mode } m} \int \ln[[2\pi T(m+\eta)]^2 + \vec{p}^2 + M_n^2] = [\text{Effective potential } (T=0)] + [\text{finite correction } (\tilde{m} \neq 0)]$$

Zero tempereture effective potential
[arXiv:1301.1744]

Finite temperature corrections:

M(W), M(Z),M(H),M(t) are KK tower for W, Z, Higgs and top

$$V_{\rm eff}(\theta_H;\xi,c_t,c_F,n_F,k,z_L) = 2(3-\xi^2)I[Q_W] + (3-\xi^2)I[Q_Z] + 3\xi^2 I[Q_S] - 12\{I[Q_{\rm top}] + I[Q_{\rm bottom}]\} - 8n_F I[Q_F] ,$$

$$I[Q(q;\theta_H)] = \frac{(kz_L^{-1})^4}{(4\pi)^2}\int_0^\infty dq\, q^3 \ln\{1+Q(q;\theta_H)\} ,$$

$$Q_W = \cos^2\theta_W Q_Z = \tfrac{1}{2}Q_S = \tfrac{1}{2}Q_0[q;\tfrac{1}{2}]\sin^2\theta_H ,$$

$$Q_{\rm top} = \frac{Q_{\rm bottom}}{r_t} = \frac{Q_0[q;c_t]}{2(1+r_t)}\sin^2\theta_H , \quad Q_F = Q_0[q;c_F]\cos^2\tfrac{1}{2}\theta_H ,$$

$$Q_0[q;c] = \frac{z_L}{q^2\hat{F}_{c-\frac{1}{2},c-\frac{1}{2}}(qz_L^{-1},q)\hat{F}_{c+\frac{1}{2},c+\frac{1}{2}}(qz_L^{-1},q)} . \quad (1)$$

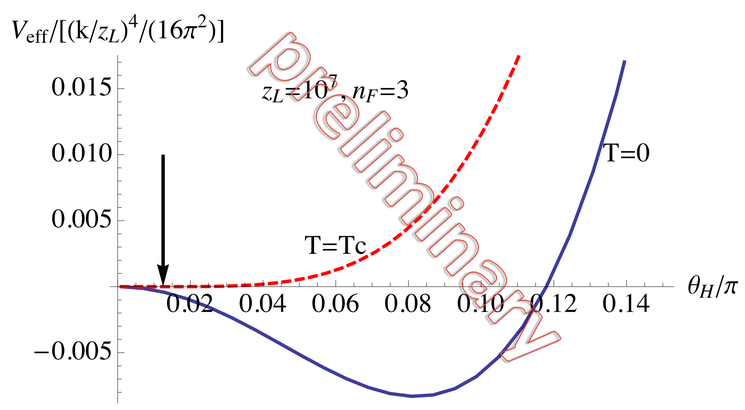
Here $\hat{F}_{\alpha,\beta}(u,v) = I_\alpha(u)K_\beta(v) - e^{-i(\alpha-\beta)\pi}K_\alpha(u)I_\beta(v)$, where I_α, K_α are modified Bessel

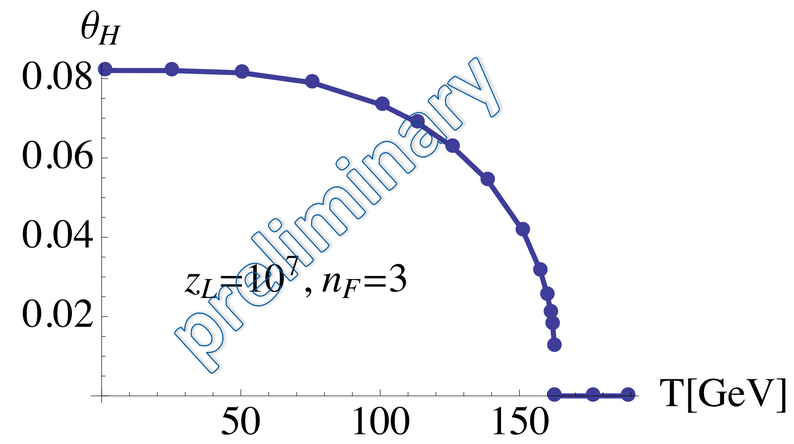
$$\Delta V_{\rm eff} = -\frac{T^4}{2\pi^2}\Big\{G[\{m_n^{(W)}\},0] + G[\{m_n^{(Z)}\},0] + G[\{m_n^{(H)}\},0] + G[\{m_n^{(t)}\},\tfrac{1}{2}] + G[\{m_n^{(F)}\},\tfrac{1}{2}]\Big\},$$

$$G[\{M_n\},\eta] = (-1)^{2\eta}\sum_{m=1}^{\infty}\sum_n \frac{(-1)^{2m\eta}}{m^d}B_2(mM_n/T)$$

Numerical Study (preliminary)

SO(5)xU(1) model with
nF=3 spinorial fermions
(c.f. arXiv:1301.1744)





warp factor zL	2x10^4	10^5	10^7	10^10	10^12
Tc[GeV]	168	161	163	190	215
mKK[TeV]	7.54	5.91	3.15	1.59	1.19

Result :Almost 2nd order (or very weak 1st order) phase transition

Discussion

Similarity with SM (couplings, high mKK…)
Mechanism of Baryogenesis : full 5D ?