Erratum: Split NMSSM with electroweak baryogenesis

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ERRATUM TO: [JHEP11\(2016\)148](#)

ARXIV EPRINT: [1608.01985](#)

A mistake has been found in the numerical procedure which finds profiles of critical bubble and values of $S_3(T_c)/T_c$. It affects both benchmark points and makes them phenomenologically unacceptable from the point of view of successful electroweak baryogenesis. In this erratum we describe new pair of model parameters with correctly calculated $S_3(T)/T$ and needed value of the generated baryon asymmetry. The final conclusions of our paper concerning consistency of split NMSSM with LHC observation of 125 GeV Higgs boson, LHC limits on superpartners, limits on electron and neutron EDMs as well as viability of electroweak baryogenesis in the model remain unchanged.

To find phenomenologically accepted model we extend our parameter space as compared to the original version of the paper. Namely, we admit mixing of the Higgs boson h with scalar S and pseudoscalar P and parametrize them as follows (cf. eq. (2.8) in [1])

$$\tilde{A}_1 = \sqrt{2}(\kappa_1 - \kappa_2) + \delta\tilde{A}_1, \quad \tilde{A}_2 = -\sqrt{2}(\kappa_1 + \kappa_2) + \delta\tilde{A}_2. \quad (1)$$

The parameters $\delta\tilde{A}_1$ and $\delta\tilde{A}_2$ are taken to be relatively small to make this mixing phenomenologically allowed. Next, we treat $\text{Im } \mu$ as a free parameter of the model (independent on $\tilde{A}_1$) by introducing corresponding soft term in the original lagrangian. We also allow for nonzero value of $\tilde{A}_r$ and complex value of $\tilde{A}_k$. Finally, we are left with eleven independent dimensionful real parameters of the model set at the EW scale

$$(v_S, v_P, M_1, M_2, \text{Re } \tilde{A}_k, \text{Im } \tilde{A}_k, \delta\tilde{A}_1, \delta\tilde{A}_2, \tilde{A}_3, \tilde{A}_r, \text{Im } \mu). \quad (2)$$

In table 2 and 1 we collect dimensionful parameters of the model and relevant parameters of the first order electroweak phase transition for two benchmark models: critical

	$\text{Im } \tilde{A}_k$	$\text{Re } \tilde{A}_k$	$\tilde{A}_r(\text{GeV}^3)$	$\tilde{A}_3$	$\delta\tilde{A}_1$	$\delta\tilde{A}_2$
Setup 1	-2.8	1.25	4000	0	1.0	-0.51
Setup 2	-3.17	1.29	-4000	0	1.45	-0.35

Table 1. Dimensionful parameters of the model (all quantities in GeV except $\tilde{A}_r$).

	v_S	v_P	$\text{Im } \mu$	T_c	v_c	S_c	P_c	S_s	P_s	S_3/T_c
Setup 1	-34	-249	-115.6	74	228.7	-34.2	-248.1	-235.3	-114.4	138.2
Setup 2	-33.5	-239	-114.3	79.5	220.7	-33.6	-238.0	-221.7	-120.2	134.1

Table 2. Parameters for the first order EWPT in the split NMSSM (all quantities in GeV except dimensionless ratio S_3/T_c).

Figure 3. The critical bubble profiles for the parameter set presented in tables 1 and 2.

values of the fields, critical temperature, S_3/T_c . Bounce profiles are presented in figure 5. In figure 4 we show baryon asymmetry as a function of wino mass parameter M_2 for the revised benchmark setups. Finally, figure 5 contains limits on chargino and neutralino masses from the bounds on EDM of electron and neutron.

For the Setup 1 we present an examples of chargino and neutralino mass spectra which are consistent with the EDM bounds in figure 5 for $M_1 = 300 \text{ GeV}$ and $M_2 = 1 \text{ TeV}$

- $m_{\chi_1^+} = 219.4 \text{ GeV}$, $m_{\chi_2^+} = 1006.7 \text{ GeV}$,
- $m_{\chi_1^0} = 136.1 \text{ GeV}$, $m_{\chi_2^0} = 208.6 \text{ GeV}$, $m_{\chi_3^0} = 254.4 \text{ GeV}$, $m_{\chi_4^0} = 332.7 \text{ GeV}$, $m_{\chi_5^0} = 1006.8 \text{ GeV}$.

Figure 4. Plot of Δ_B/Δ_0 versus gaugino mass parameter M_2 for the parameter sets presented in tables 1 and 2.

Figure 5. Left panel: the EDM of electron versus the lightest chargino mass $m_{\chi_1^+}$. Dotted line indicates the current experimental bound $|d_e/e| < 8.7 \times 10^{-29}$ cm. Right panel: the same for the neutron's EDM with current upper limit $|d_n/e| < 3.0 \times 10^{-26}$ cm. The relevant parameters are given in tables 1 and 2.

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References

- [1] S.V. Demidov, D.S. Gorbunov and D.V. Kirpichnikov, *Split NMSSM with electroweak baryogenesis*, *JHEP* **11** (2016) 148 [[arXiv:1608.01985](https://arxiv.org/abs/1608.01985)] [[INSPIRE](https://inspirehep.net/literature/1608019)].