

Abe, Hiroyuki; Ishida, Makoto; Tatsuta, Yoshiyuki

Effects of localized μ -terms at the fixed points in magnetized orbifold models. (English)

Zbl 1435.81253

Nucl. Phys., B 947, Article ID 114732, 20 p. (2019).

Summary: We consider magnetized orbifolds, where the supersymmetric mass term for a pair of up- and down-type Higgs (super)fields, called μ -term, is localized at the orbifold fixed points, and study the effects on the zero-mode spectra. The zero-mode degeneracy to be identified as the generation in four-dimensional (4D) effective theories is determined by the magnetic fluxes. It is known that multiple Higgs zero-modes appear in general in magnetized orbifold models. We derive the analytic form of the μ -term matrix in the 4D effective theory generated by the localized sources on T^2/Z_2 orbifold fixed points, and find that this matrix can lead to a distinctive pattern of the eigenvalues that yields hierarchical μ -terms for the multiple Higgs fields. The lightest ones can be exponentially suppressed due to the localized wavefunctions of zero-modes determined by the fluxes, while the others are of the order of the compactification scale, which can provide a dynamical origin of the electroweak scale as well as a simultaneous decoupling of extra Higgs fields. We also show that a certain linear combination of the lightest Higgs fields could generate the observed mass ratios of down-type quarks through their Yukawa couplings determined by the wavefunctions.

MSC:

- 81V22 Unified quantum theories
- 81T60 Supersymmetric field theories in quantum mechanics
- 57R18 Topology and geometry of orbifolds
- 81T12 Effective quantum field theories
- 81V10 Electromagnetic interaction; quantum electrodynamics
- 81T33 Dimensional compactification in quantum field theory
- 81V05 Strong interaction, including quantum chromodynamics

Full Text: [DOI](#)

References:

- [1] Bachas, C., A way to break supersymmetry
- [2] Cremades, D.; Ibanez, L. E.; Marchesano, F., Computing Yukawa couplings from magnetized extra dimensions, *J. High Energy Phys.*, 05, Article 079 pp. (2004)
- [3] Ibanez, L. E.; Uranga, A. M., *String Theory and Particle Physics: An Introduction to String Phenomenology* (2012), Cambridge University Press · Zbl 1260.81001
- [4] Braun, A. P.; Hebecker, A.; Trapletti, M., Flux stabilization in 6 dimensions: D-terms and loop corrections, *J. High Energy Phys.*, 02, Article 015 pp. (2007)
- [5] Abe, H.; Kobayashi, T.; Ohki, H., Magnetized orbifold models, *J. High Energy Phys.*, 09, Article 043 pp. (2008) · Zbl 1245.81254
- [6] Abe, H.; Choi, K.-S.; Kobayashi, T.; Ohki, H., Three generation magnetized orbifold models, *Nucl. Phys. B*, 814, 265-292 (2009) · Zbl 1194.81248
- [7] Abe, H.; Choi, K.-S.; Kobayashi, T.; Ohki, H., Magnetic flux, Wilson line and orbifold, *Phys. Rev. D*, 80, Article 126006 pp. (2009)
- [8] Abe, H.; Kobayashi, T.; Ohki, H.; Sumita, K., Superfield description of 10D SYM theory with magnetized extra dimensions, *Nucl. Phys. B*, 863, 1-18 (2012) · Zbl 1246.81347
- [9] Abe, H.; Kobayashi, T.; Ohki, H.; Oikawa, A.; Sumita, K., Phenomenological aspects of 10D SYM theory with magnetized extra dimensions, *Nucl. Phys. B*, 870, 30-54 (2013) · Zbl 1262.81250
- [10] Abe, H.; Kobayashi, T.; Ohki, H.; Sumita, K.; Tatsuta, Y., Flavor landscape of 10D SYM theory with magnetized extra dimensions, *J. High Energy Phys.*, 04, Article 007 pp. (2014)
- [11] Abe, H.; Kobayashi, T.; Ohki, H.; Sumita, K.; Tatsuta, Y., Non-Abelian discrete flavor symmetries of 10D SYM theory with magnetized extra dimensions, *J. High Energy Phys.*, 06, Article 017 pp. (2014)
- [12] Abe, H.; Kawamura, J.; Sumita, K., The Higgs boson mass and SUSY spectra in 10D SYM theory with magnetized extra dimensions, *Nucl. Phys. B*, 888, 194-213 (2014) · Zbl 1326.81254
- [13] Abe, H.; Kobayashi, T.; Sumita, K.; Tatsuta, Y., Gaussian Froggatt-Nielsen mechanism on magnetized orbifolds, *Phys. Rev.*

- D, 90, 10, Article 105006 pp. (2014)
- [14] Buchmuller, W.; Dierigl, M.; Ruehle, F.; Schweizer, J., Chiral fermions and anomaly cancellation on orbifolds with Wilson lines and flux, *Phys. Rev. D*, 92, 10, Article 105031 pp. (2015)
 - [15] Buchmuller, W.; Dierigl, M.; Ruehle, F.; Schweizer, J., Split symmetries, *Phys. Lett. B*, 750, 615-619 (2015) · [Zbl 1364.83058](#)
 - [16] Abe, H.; Kobayashi, T.; Sumita, K.; Tatsuta, Y., Supersymmetric models on magnetized orbifolds with flux-induced Fayet-Iliopoulos terms, *Phys. Rev. D*, 95, 1, Article 015005 pp. (2017)
 - [17] Kobayashi, T.; Nishiwaki, K.; Tatsuta, Y., CP-violating phase on magnetized toroidal orbifolds, *J. High Energy Phys.*, 04, Article 080 pp. (2017)
 - [18] Fujimoto, Y.; Kobayashi, T.; Miura, T.; Nishiwaki, K.; Sakamoto, M., Shifted orbifold models with magnetic flux, *Phys. Rev. D*, 87, 8, Article 086001 pp. (2013)
 - [19] Abe, T.-H.; Fujimoto, Y.; Kobayashi, T.; Miura, T.; Nishiwaki, K.; Sakamoto, M., (Z_N) twisted orbifold models with magnetic flux, *J. High Energy Phys.*, 01, Article 065 pp. (2014)
 - [20] Abe, T.-h.; Fujimoto, Y.; Kobayashi, T.; Miura, T.; Nishiwaki, K.; Sakamoto, M., Operator analysis of physical states on magnetized (T^2 / Z_N) orbifolds, *Nucl. Phys. B*, 890, 442-480 (2014) · [Zbl 1326.81255](#)
 - [21] Abe, T.-h.; Fujimoto, Y.; Kobayashi, T.; Miura, T.; Nishiwaki, K.; Sakamoto, M.; Tatsuta, Y., Classification of three-generation models on magnetized orbifolds, *Nucl. Phys. B*, 894, 374-406 (2015) · [Zbl 1328.81219](#)
 - [22] Fujimoto, Y.; Kobayashi, T.; Nishiwaki, K.; Sakamoto, M.; Tatsuta, Y., Comprehensive analysis of Yukawa hierarchies on (T^2 / Z_N) with magnetic fluxes, *Phys. Rev. D*, 94, 3, Article 035031 pp. (2016)
 - [23] Buchmuller, W.; Dierigl, M.; Dudas, E.; Schweizer, J., Effective field theory for magnetic compactifications, *J. High Energy Phys.*, 04, Article 052 pp. (2017)
 - [24] Martin, S. P., A supersymmetry primer, *Adv. Ser. Dir. High Energy Phys.*, 18, 1 (1998) · [Zbl 1106.81320](#)
 - [25] Ishida, M.; Nishiwaki, K.; Tatsuta, Y., Brane-localized masses in magnetic compactifications, *Phys. Rev. D*, 95, 9, Article 095036 pp. (2017)
 - [26] Ishida, M.; Nishiwaki, K.; Tatsuta, Y., Seesaw mechanism in magnetic compactifications, *J. High Energy Phys.*, 07, Article 125 pp. (2018)
 - [27] Hamada, Y.; Kobayashi, T., Massive modes in magnetized brane models, *Prog. Theor. Phys.*, 128, 903-923 (2012)
 - [28] Conlon, J. P.; Maharana, A.; Quevedo, F., Wave functions and Yukawa couplings in local string compactifications, *J. High Energy Phys.*, 09, Article 104 pp. (2008) · [Zbl 1245.83057](#)
 - [29] Abe, H.; Horie, T.; Sumita, K., Superfield description of $(4+2n)$ -dimensional SYM theories and their mixtures on magnetized tori, *Nucl. Phys. B*, 900, 331-365 (2015) · [Zbl 1331.81184](#)
 - [30] Arkani-Hamed, N.; Gregoire, T.; Wacker, J. G., Higher dimensional supersymmetry in 4-D superspace, *J. High Energy Phys.*, 03, Article 055 pp. (2002)
 - [31] Green, M. B.; Schwarz, J. H., Anomaly cancellation in supersymmetric D=10 Gauge theory and superstring theory, *Phys. Lett. B*, 149, 117-122 (1984)
 - [32] Sakamura, Y., Spectrum in the presence of brane-localized mass on torus extra dimensions, *J. High Energy Phys.*, 10, Article 083 pp. (2016)
 - [33] Ibanez, L. E.; Uranga, A. M., Neutrino Majorana masses from string theory instanton effects, *J. High Energy Phys.*, 03, Article 052 pp. (2007)
 - [34] Blumenhagen, R.; Cvetic, M.; Weigand, T., Spacetime instanton corrections in 4D string vacua: the seesaw mechanism for D-brane models, *Nucl. Phys. B*, 771, 113-142 (2007) · [Zbl 1117.81112](#)
 - [35] Abe, H.; Kobayashi, T.; Tatsuta, Y.; Uemura, S., D-brane instanton induced (μ) terms and their hierarchical structure, *Phys. Rev. D*, 92, 2, Article 026001 pp. (2015)
 - [36] Kobayashi, T.; Tatsuta, Y.; Uemura, S., Majorana neutrino mass structure induced by rigid instantons on toroidal orbifold, *Phys. Rev. D*, 93, 6, Article 065029 pp. (2016)
 - [37] Lust, D.; Reffert, S.; Scheidegger, E.; Stieberger, S., Resolved toroidal orbifolds and their orientifolds, *Adv. Theor. Math. Phys.*, 12, 1, 67-183 (2008) · [Zbl 1152.81883](#)
 - [38] Groot Nibbelink, S.; Trapletti, M.; Walter, M., Resolutions of $C^n/Z(n)$ orbifolds, their $U(1)$ bundles, and applications to string model building, *J. High Energy Phys.*, 03, Article 035 pp. (2007)
 - [39] Groot Nibbelink, S.; Held, J.; Ruehle, F.; Trapletti, M.; Vaudrevange, P. K.S., Heterotic $Z(6-II)$ MSSM orbifolds in blowup, *J. High Energy Phys.*, 03, Article 005 pp. (2009)
 - [40] Blaszczyk, M.; Groot Nibbelink, S.; Ruehle, F.; Trapletti, M.; Vaudrevange, P. K.S., Heterotic MSSM on a resolved orbifold, *J. High Energy Phys.*, 09, Article 065 pp. (2010) · [Zbl 1291.81296](#)

This reference list is based on information provided by the publisher or from digital mathematics libraries. Its items are heuristically matched to zbMATH identifiers and may contain data conversion errors. It attempts to reflect the references listed in the original paper as accurately as possible without claiming the completeness or perfect precision of the matching.