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**Classification of three-generation models on magnetized orbifolds.** (English) Zbl 1328.81219  
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Summary: We classify the combinations of parameters which lead three generations of quarks and leptons in the framework of magnetized twisted orbifolds on  $T^2/Z_2$ ,  $T^2/Z_3$ ,  $T^2/Z_4$ , and  $T^2/Z_6$  with allowing nonzero discretized Wilson line phases and Scherk-Schwarz phases. We also analyze two actual examples with nonzero phases leading to one-pair Higgs and five-pair Higgses and discuss the difference from the results without nonzero phases studied previously.

**MSC:**

**81V05** Strong interaction, including quantum chromodynamics  
**81V15** Weak interaction in quantum theory  
**57R10** Smoothing in differential topology

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**Keywords:**

nonzero discretized Wilson line phases; Scherk-Schwarz phases

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**References:**

- [1] Aad, G., Observation of a new particle in the search for the standard model Higgs boson with the ATLAS detector at the LHC, Phys. Lett. B, 716, 1-29, (2012)
- [2] Chatrchyan, S., Observation of a new boson at a mass of 125 gev with the CMS experiment at the LHC, Phys. Lett. B, 716, 30-61, (2012)
- [3] Bachas, C., A way to break supersymmetry
- [4] Blumenhagen, R.; Goerlich, L.; Kors, B.; Lust, D., Noncommutative compactifications of type I strings on tori with magnetic background flux, J. High Energy Phys., 0010, 006, (2000) · [Zbl 0965.81113](#)
- [5] Angelantonj, C.; Antoniadis, I.; Dudas, E.; Sagnotti, A., Type I strings on magnetized orbifolds and brane transmutation, Phys. Lett. B, 489, 223-232, (2000) · [Zbl 1031.81579](#)
- [6] Blumenhagen, R.; Kors, B.; Lust, D., Type I strings with F flux and B flux, J. High Energy Phys., 0102, 030, (2001)
- [7] Cremades, D.; Ibanez, L.; Marchesano, F., Computing Yukawa couplings from magnetized extra dimensions, J. High Energy Phys., 0405, 079, (2004)
- [8] Blumenhagen, R.; Cvetic, M.; Langacker, P.; Shiu, G., Toward realistic intersecting D-brane models, Annu. Rev. Nucl. Part. Sci., 55, 71-139, (2005)
- [9] Blumenhagen, R.; Kors, B.; Lust, D.; Stieberger, S., Four-dimensional string compactifications with D-branes, orientifolds and fluxes, Phys. Rep., 445, 1-193, (2007)
- [10] Fujimoto, Y.; Nagasawa, T.; Nishiwaki, K.; Sakamoto, M., Quark mass hierarchy and mixing via geometry of extra dimension with point interactions, Prog. Theor. Exp. Phys., 2013, 023B07, (2013)
- [11] Fujimoto, Y.; Nishiwaki, K.; Sakamoto, M., CP phase from twisted Higgs VEV in extra dimension, Phys. Rev. D, 88, 115007, (2013)
- [12] Fujimoto, Y.; Nishiwaki, K.; Sakamoto, M.; Takahashi, R., Realization of lepton masses and mixing angles from point interactions in an extra dimension, J. High Energy Phys., 1410, 191, (2014)
- [13] 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](#)
- [14] Abe, H.; Kobayashi, T.; Sumita, K.; Tatsuta, Y., Gaussian Froggatt-Nielsen mechanism on magnetized orbifolds, Phys. Rev. D, 90, 10, 105006, (2014)
- [15] Abe, H.; Choi, K.-S.; Kobayashi, T.; Ohki, H., Higher order couplings in magnetized brane models, J. High Energy Phys., 0906, 080, (2009)
- [16] Abe, H.; Choi, K.-S.; Kobayashi, T.; Ohki, H., Non-abelian discrete flavor symmetries from magnetized/intersecting brane models, Nucl. Phys. B, 820, 317-333, (2009) · [Zbl 1194.81178](#)
- [17] Abe, H.; Choi, K.-S.; Kobayashi, T.; Ohki, H., Magnetic flux, Wilson line and orbifold, Phys. Rev. D, 80, 126006, (2009)

- [18] Abe, H.; Choi, K.-S.; Kobayashi, T.; Ohki, H., Flavor structure from magnetic fluxes and non-abelian Wilson lines, *Phys. Rev. D*, 81, 126003, (2010)
- [19] Berasaluce-Gonzalez, M.; Camara, P.; Marchesano, F.; Regalado, D.; Uranga, A., Non-abelian discrete gauge symmetries in 4d string models, *J. High Energy Phys.*, 1209, 059, (2012) · [Zbl 1397.83125](#)
- [20] Honecker, G.; Staessens, W., To tilt or not to tilt: discrete gauge symmetries in global intersecting d-brane models, *J. High Energy Phys.*, 1310, 146, (2013)
- [21] Marchesano, F.; Regalado, D.; Vazquez-Mercado, L., Discrete flavor symmetries in D-brane models, *J. High Energy Phys.*, 1309, 028, (2013)
- [22] 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.*, 1406, 017, (2014)
- [23] Hamada, Y.; Kobayashi, T., Massive modes in magnetized brane models, *Prog. Theor. Phys.*, 128, 903-923, (2012)
- [24] Sakamoto, M.; Tanimura, S., An extension of Fourier analysis for the  $n$  torus in the magnetic field and its application to spectral analysis of the magnetic Laplacian, *J. Math. Phys.*, 44, 5042-5069, (2003) · [Zbl 1062.81037](#)
- [25] Antoniadis, I.; Maillard, T., Moduli stabilization from magnetic fluxes in type I string theory, *Nucl. Phys. B*, 716, 3-32, (2005) · [Zbl 1207.81098](#)
- [26] Antoniadis, I.; Kumar, A.; Panda, B., Fermion wavefunctions in magnetized branes: theta identities and Yukawa couplings, *Nucl. Phys. B*, 823, 116-173, (2009) · [Zbl 1196.81188](#)
- [27] Choi, K.-S.; Kobayashi, T.; Maruyama, R.; Murata, M.; Nakai, Y.,  $E(6, 7, 8)$  magnetized extra dimensional models, *Eur. Phys. J. C*, 67, 273-282, (2010)
- [28] Kobayashi, T.; Maruyama, R.; Murata, M.; Ohki, H.; Sakai, M., Three-generation models from  $E_8$  magnetized extra dimensional theory, *J. High Energy Phys.*, 1005, 050, (2010) · [Zbl 1287.81124](#)
- [29] Di Vecchia, P.; Marotta, R.; Pesando, I.; Pezzella, F., Open strings in the system  $D5 / D9$ , *J. Phys. A*, 44, 245401, (2011) · [Zbl 1222.81234](#)
- [30] 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](#)
- [31] De Angelis, L.; Marotta, R.; Pezzella, F.; Troise, R., More about branes on a general magnetized torus, *J. High Energy Phys.*, 1210, 052, (2012)
- [32] Abe, H.; Kobayashi, T.; Ohki, H.; Sumita, K.; Tatsuta, Y., Flavor landscape of 10D SYM theory with magnetized extra dimensions
- [33] Hamada, Y.; Kobayashi, T.; Uemura, S., Flavor structure in D-brane models: Majorana neutrino masses
- [34] Cremades, D.; Ibanez, L.; Marchesano, F., Yukawa couplings in intersecting D-brane models, *J. High Energy Phys.*, 0307, 038, (2003)
- [35] Cvetič, M.; Papadimitriou, I., Conformal field theory couplings for intersecting D-branes on orientifolds, *Phys. Rev. D*, 68, 046001, (2003)
- [36] Abel, S.; Owen, A., Interactions in intersecting brane models, *Nucl. Phys. B*, 663, 197-214, (2003) · [Zbl 1059.81585](#)
- [37] Kobayashi, T.; Raby, S.; Zhang, R.-J., Searching for realistic 4d string models with a Pati-Salam symmetry: orbifold grand unified theories from heterotic string compactification on a  $Z(6)$  orbifold, *Nucl. Phys. B*, 704, 3-55, (2005) · [Zbl 1198.81158](#)
- [38] Kobayashi, T.; Nilles, H. P.; Ploger, F.; Raby, S.; Ratz, M., Stringy origin of non-abelian discrete flavor symmetries, *Nucl. Phys. B*, 768, 135-156, (2007) · [Zbl 1117.81354](#)
- [39] Ko, P.; Kobayashi, T.; Park, J.-h.; Raby, S., String-derived  $D(4)$  flavor symmetry and phenomenological implications, *Phys. Rev. D*, 76, 035005, (2007)
- [40] Honecker, G.; Vanhoof, J., Yukawa couplings and masses of non-chiral states for the standard model on D6-branes on  $T^6 / Z_6'$ , *J. High Energy Phys.*, 1204, 085, (2012) · [Zbl 1348.81371](#)
- [41] Beye, F.; Kobayashi, T.; Kuwakino, S., Gauge origin of discrete flavor symmetries in heterotic orbifolds, *Phys. Lett. B*, 736, 433-437, (2014) · [Zbl 1317.81215](#)
- [42] Katsuki, Y.; Kawamura, Y.; Kobayashi, T.; Ohtsubo, N.; Ono, Y.,  $Z(N)$  orbifold models, *Nucl. Phys. B*, 341, 611-640, (1990) · [Zbl 0970.81061](#)
- [43] Kobayashi, T.; Ohtsubo, N., Geometrical aspects of  $Z(N)$  orbifold phenomenology, *Int. J. Mod. Phys. A*, 9, 87-126, (1994) · [Zbl 0985.81631](#)
- [44] Choi, K.-S.; Kim, J. E., Quarks and leptons from orbifolded superstring, *Lect. Notes Phys.*, 696, 1-406, (2006) · [Zbl 1114.81002](#)
- [45] Kawamura, Y.; Kinami, T.; Miura, T., Equivalence classes of boundary conditions in gauge theory on  $Z(3)$  orbifold, *Prog. Theor. Phys.*, 120, 815-831, (2008) · [Zbl 1165.81397](#)
- [46] Kawamura, Y.; Kinami, T.; Oda, K.-y., Orbifold family unification, *Phys. Rev. D*, 76, 035001, (2007)
- [47] Kawamura, Y.; Miura, T., Equivalence classes of boundary conditions in  $\mathit{SU}(N)$  gauge theory on 2-dimensional orbifolds, *Prog. Theor. Phys.*, 122, 847-864, (2010) · [Zbl 1181.81115](#)
- [48] Kawamura, Y.; Miura, T., Orbifold family unification in  $\mathit{SO}(2N)$  gauge theory, *Phys. Rev. D*, 81, 075011, (2010)
- [49] Goto, Y.; Kawamura, Y.; Miura, T., Orbifold family unification on 6 dimensions, *Phys. Rev. D*, 88, 055016, (2013)
- [50] Goto, Y.; Kawamura, Y.; Miura, T., Family number, Wilson line phases and hidden supersymmetry, *Int. J. Mod. Phys. A*, 29, 26, 1450150, (2014) · [Zbl 1301.81073](#)

- [51] Abe, T.-h.; Fujimoto, Y.; Kobayashi, T.; Miura, T.; Nishiwaki, K., Operator analysis of physical states on magnetized  $T^2/Z_N$  orbifolds · [Zbl 1326.81255](#)
- [52] Abe, T.-H.; Fujimoto, Y.; Kobayashi, T.; Miura, T.; Nishiwaki, K.,  $Z_N$  twisted orbifold models with magnetic flux, J. High Energy Phys., 1401, 065, (2014)
- [53] Scherk, J.; Schwarz, J. H., Spontaneous breaking of supersymmetry through dimensional reduction, Phys. Lett. B, 82, 60, (1979)
- [54] Scherk, J.; Schwarz, J. H., How to get masses from extra dimensions, Nucl. Phys. B, 153, 61-88, (1979)
- [55] Ibanez, L. E.; Nilles, H. P.; Quevedo, F., Orbifolds and Wilson lines, Phys. Lett. B, 187, 25-32, (1987)
- [56] Kobayashi, T.; Ohtsubo, N., Analysis on the Wilson lines of  $Z(N)$  orbifold models, Phys. Lett. B, 257, 56-62, (1991)
- [57] Angelantonj, C.; Cardella, M.; Irges, N., Scherk-Schwarz breaking and intersecting branes, Nucl. Phys. B, 725, 115-154, (2005) · [Zbl 1178.81210](#)
- [58] Blumenhagen, R.; Cvetic, M.; Marchesano, F.; Shiu, G., Chiral D-brane models with frozen open string moduli, J. High Energy Phys., 0503, 050, (2005)
- [59] Angelantonj, C.; Condeescu, C.; Dudas, E.; Lennek, M., Stringy instanton effects in models with rigid magnetised D-branes, Nucl. Phys. B, 818, 52-94, (2009) · [Zbl 1194.81180](#)
- [60] Forste, S.; Honecker, G., Rigid D6-branes on  $T^6/(Z_2 \times Z_{2M}) \times \text{operatorname{\Omega} R}$  with discrete torsion, J. High Energy Phys., 1101, 091, (2011) · [Zbl 1214.81209](#)
- [61] Groot Nibbelink, S.; Vaudrevange, P. K., Schoen manifold with line bundles as resolved magnetized orbifolds, J. High Energy Phys., 1303, 142, (2013) · [Zbl 1342.81462](#)
- [62] Fujimoto, Y.; Kobayashi, T.; Miura, T.; Nishiwaki, K.; Sakamoto, M., Shifted orbifold models with magnetic flux, Phys. Rev. D, 87, 086001, (2013)
- [63] Abe, H.; Kobayashi, T.; Ohki, H., Magnetized orbifold models, J. High Energy Phys., 0809, 043, (2008) · [Zbl 1245.81254](#)
- [64] Abe, H.; Choi, K.-S.; Kobayashi, T.; Ohki, H., Three generation magnetized orbifold models, Nucl. Phys. B, 814, 265-292, (2009) · [Zbl 1194.81248](#)
- [65] Abe, T.-h.; Fujimoto, Y.; Kobayashi, T.; Miura, T.; Nishiwaki, K., Classification of three-generation models on magnetized orbifolds · [Zbl 1328.81219](#)
- [66] Hashimoto, A.; Taylor, W., Fluctuation spectra of tilted and intersecting D-branes from the Born-Infeld action, Nucl. Phys. B, 503, 193-219, (1997) · [Zbl 0979.81572](#)
- [67] Olive, K., Review of particle physics, Chin. Phys. C, 38, 090001, (2014)
- [68] Froggatt, C.; Nielsen, H. B., Hierarchy of quark masses, cabibbo angles and CP violation, Nucl. Phys. B, 147, 277, (1979)

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