zbMATH Open
THE FIRST RESOURCE FOR MATHEMATICS

Edwards, James P.

Unified theory in the worldline approach. (English) Zbl 1364.81254

Phys. Lett., B 750, 312-318 (2015).

Summary: We explore unified field theories based on the gauge groups SU(5) and SO(10) using the worldline approach for chiral fermions with a Wilson loop coupling to a background gauge field. Representing path ordering and chiral projection operators with functional integrals has previously reproduced the sum over the chiralities and representations of standard model particles in a compact way. This paper shows that for SU(5) the $\overline{5}$ and 10 representations – into which the Georgi-Glashow model places the left-handed fermionic content of the standard model – appear naturally and with the familiar chirality. We carry out the same analysis for flipped SU(5) and uncover a link to SO(10) unified theory. We pursue this by exploring the SO(10) theory in the same framework, the less established unified theory based on SU(6) and briefly consider the Pati-Salam model using SU(4) × SU(2) × SU(2).

MSC:

81V22 Unified quantum theories
81R05 Finite-dimensional groups and algebras motivated by physics and their representations
81T13 Yang-Mills and other gauge theories in quantum field theory

Cited in **4** Documents

Keywords:

quantum electrodynamics; standard model; unification; Wilson loop

Full Text: DOI arXiv

References:

[1] Strassler, M. J., Field theory without Feynman diagrams: one loop effective actions, Nucl. Phys. B, 385, 145-184, (1992)

[2] M.J. Strassler, Field theory without Feynman diagrams: a demonstration using actions induced by heavy particles, SLAC-PUB-5978.

[3] Mansfield, P., The fermion content of the standard model from a simple world-line theory, Phys. Lett. B, 743, 0, 353-356, (2015) · Zbl 1343.81230

[4] Schubert, C., Perturbative quantum field theory in the string inspired formalism, Phys. Rep., 355, 73-234, (2001) · Zbl 0988.81108

[5] Bastianelli, F.; Corradini, O.; Pisani, P. A.G., Worldline approach to quantum field theories on flat manifolds with boundaries, J. High Energy Phys., 59, (2007)

[6] Edwards, J. P.; Mansfield, P., QED as the tensionless limit of the spinning string with contact interaction, Phys. Lett. B, 746, 0, 335-340, (2015) · Zbl 1343.81217

[7] Langacker, P., Grand unified theories and proton decay, Phys. Rep., 72, 4, 185-385, (1981)

[8] Georgi, H.; Glashow, S. L., Unity of all elementary-particle forces, Phys. Rev. Lett., 32, 438-441, (1974)

[9] Alvarez-Gaume, L.; Witten, E., Gravitational anomalies, Nucl. Phys. B, 234, 269, (1984)

[10] Mondragon, M.; Nellen, L.; Schmidt, M. G.; Schubert, C., Axial couplings on the worldline, Phys. Lett. B, 366, 212-219, (1996)

[11] Brink, L.; Di Vecchia, P.; Howe, P., A Lagrangian formulation of the classical and quantum dynamics of spinning particles, Nucl. Phys. B, 118, 76-94, (1977)

[12] Ahmadiniaz, N.; Schubert, C.; Villanueva, V. M., String-inspired representations of photon/gluon amplitudes, J. High Energy Phys., 1301, (2013)

[13] Sato, H.-T.; Schmidt, M. G., Worldline approach to the Bern-kosower formalism in two loop Yang-Mills theory, Nucl. Phys. B, 560, 551-586, (1999)

[14] Balachandran, A.; Salomonson, P.; Skagerstam, B.-S.; Winnberg, J.-O., Classical description of particle interacting with nonabelian gauge field, Phys. Rev. D, 15, 2308, (1977)

[15] Samuel, S., Color Zitterbewegung, Nucl. Phys. B, 149, 517, (1979)

[16] D'Hoker, E.; Gagne, D. G., Worldline path integrals for fermions with general couplings, Nucl. Phys. B, 467, 297-312, (1996)

© 2021 FIZ Karlsruhe GmbH

· Zbl 1002.81515

[17] Ishida, J.; Hosoya, A., Path-integral for a colour spin and path-ordered phase factor, Prog. Theor. Phys., 62, 2, 544-553, (1979)

[18] Bastianelli, F.; Bonezzi, R.; Corradini, O.; Latini, E., Particles with non abelian charges, J. High Energy Phys., 1310, (2013) · Zbl 1342.81660

[19] Bastianelli, F.; Bonezzi, R.; Corradini, O.; Latini, E.; Ould-Lahoucine, K. H., A worldline approach to colored particles

[20] Edwards, J. P.; Mansfield, P., Delta-function interactions for the bosonic and spinning strings and the generation of abelian gauge theory, J. High Energy Phys., 01, (2015)

[21] Bailin, D.; Love, A., Introduction to gauge field theory, (1994), Institute of Physics Publishing

[22] Barr, S. M., A new symmetry breaking pattern for SO(10) and proton decay, Phys. Lett. B, 112, 219, (1982)

[23] Derendinger, J.; Kim, J. E.; Nanopoulos, D. V., Anti-SU(5), Phys. Lett. B, 139, 170, (1984)

[24] Zee, A., Quantum field theory in a nutshell, (2003), Princeton Univ. Press Princeton, NJ, Nutshell handbook · Zbl 1048.81002

[25] Masiero, A., On the phenomenological group in unified SO(10) model, Phys. Lett. B, 93, 295, (1980)

[26] Hartanto, A.; Handoko, L., Grand unified theory based on the SU(6) symmetry, Phys. Rev. D, 71, (2005)

[27] Fukugita, M.; Yanagida, T.; Yoshimura, M., $N \overline{N}$ oscillation without left-right symmetry, Phys. Lett. B, 109, 369, (1982)

[28] Fritzsch, H.; Minkowski, P., Unified interactions of leptons and hadrons, Ann. Phys., 93, 1-2, 193-266, (1975)

[29] Baez, J. C.; Huerta, J., The algebra of grand unified theories, Bull. Am. Math. Soc., 47, 483-552, (2010) · Zbl 1196.81252

[30] Pati, J. C.; Salam, A.; Pati, J. C.; Salam, A., Lepton number as the fourth color, Phys. Rev. D, 10, 275-289, (1974), (Erratum)

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.