Contribution ID: **336** Type: **not specified**

Exploring the BSM Potential of Anomalous Neutral Gauge Couplin Phase Transition with CEPC Detector Simulation

Friday, 25 October 2024 09:00 (23 minutes)

https://arxiv.org/abs/2404.15937
Front. Phys. 20(1), 015201 (2025) [doi:10.15302/frontphys.2025.015201] (Cover Story Highlight)

Neutral triple gauge couplings (nTGCs) are absent in the Standard Model (SM) and at the dimension-6 level in the Standard Model Effective Field Theory (SMEFT), arising first from dimension-8 operators. As such, they provide a unique window for probing new physics beyond the SM. These dimension-8 operators can be mapped to nTGC form factors whose structure is consistent with the spontaneously-broken electroweak gauge symmetry of the SM. In this work, we study the probes of nTGCs in the reaction $e^+e^-\to Z\gamma$ with $Z\to\ell^+\ell^-$(ℓ = e,μ) at an e^+e^- collider. We perform a detector-level simulation and analysis of this reaction at the Circular Electron Positron Collider (CEPC) with collision energy $\sqrt{s}$ = 240 GeV and an integrated luminosity of 5 ab^{-1}. We present the sensitivity limits on probing the new physics scales of dimension-8 nTGC operators via measurements of the corresponding nTGC form factors.

https://arxiv.org/abs/2203.10184
LHEP 2023 (2023) 436 [doi:10.31526/lhep.2023.436]

A strong first-order electroweak phase transition (EWPT) can be induced by light new physics weakly coupled to the Higgs. This study focuses on a scenario in which the first-order EWPT is driven by a light scalar s with a mass between 15-60 GeV. A search for exotic decays of the Higgs boson into a pair of spin-zero particles, $h\to ss$, where the s-boson decays into b-quarks promptly is presented. The search is performed in events where the Higgs boson is produced in association with a Z boson, giving rise to a signature of two charged leptons (electrons or muons) and multiple jets from b-quark decays. The analysis is considering a scenario of analysing 5000 fb^{-1} e^+e^- collision data at $\sqrt{s}$ = 240 GeV from the Circular Electron Positron Collider (CEPC). This study with 4b final state conclusively tests the expected sensitivity of probing the light scalars in the CEPC experiment. The sensitivity reach is significantly larger than that can be achieved at the LHC.

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Session Classification: Higgs