Radiative mass models for EDM and g-2 of the tau lepton

Yoshihiro SHIGEKAMI[1], Yuichiro Nakai[2,3], Peng Sun[2,3], Zhihao Zhang[2,3]

1. Henan Normal University
2. Shanghai Jiao Tong University
3. Tsung-Dao Lee Institute

The Belle II experiment and other ongoing and projected lepton facilities are expected to greatly enhance the sensitivity to the electric dipole moment (EDM) and anomalous magnetic moment (g-2) for the tau lepton, making it timely to explore models that predict these observables. We present a class of models that generate a sizable EDM and g-2 of the tau lepton via radiative tau mass generation. Two benchmark models with different hypercharge assignments are investigated. The first model contains neutral fermions and charged scalars. We find that the model can predict a large signal of the tau EDM, $d_\tau = O(10^{-19})$ ecm, and g-2, $a_\tau = O(10^{-5})$, which are within the reach of future updates of their measurements. In contrast, the second model, containing charged fermions and neutral scalars, yields a similar magnitude for the g-2 but predicts a comparatively smaller EDM signal. Our models serve as benchmarks for new physics generating sizable EDM and g-2 of the tau lepton.

Non-abelian Domain walls

Bowen Fu

Northeastern University, China

Domain wall is one of the topological defects that can be generated during phase transitions. When a non-abelian discrete symmetry is broken, different types of domain walls can be created. Starting from a real scalar model with 4 symmetry, we study the properties of different types of domain walls and then extend the analysis to models with 4 symmetry as well as complex scalar models.

Strong Coupling from Inclusive Semileptonic Decay of D and B Mesons

Yuzhi Che

中国科学院高能物理研究所 (Institute of High Energy Physics, CAS)

Quantum Chromodynamics (QCD) is the gauge field theory of the strong interaction, in which gluons are the force mediators and the effective strong interaction constant, α_s, dictates the strength of the strong interaction. The striking properties of asymptotic freedom and color confinement were predicted and confirmed through the measurements of α_s at high energies. However the value of α_s and its running in low energy region are much less understood compared to any other fundamental coupling in nature. Accurate measurements of α_s are crucial for understanding QCD and searching for possible new physics.

In this contribution, we discuss extracting α_s from the semileptonic deacys of D and B mesons within the framework of the Heavy Quark Expansion (HQE). We express the semileptonic decay widths of the D0 and the D+ as a function of $\alpha_s(m_c)$, the Cabibbo-Kobayashi-Maskawa matrix element ($|V_{cs}|$) and HQE parameters with the kinetic scheme, and determine $\alpha_s(m_c)$ using the experimental values of the decay widths, yielding $\alpha_s(m_c) = 0.445 \pm 0.114$. Besides, we build the similar theory model for the inclusive semileptonic decay width of B mesons with the modified minimal subtraction scheme. The $\alpha_s(5\ \mathrm{GeV})$ is fitted to match the world average semi-leptonic decay widths of $B^\pm$ and B^0 mesons, yielding $\alpha_s(5\ \mathrm{GeV}) = 0.245 \pm 0.009$. The primary uncertainty contributions arise from the uncertainty on the perturbative expansion and the value of $|V_{cb}|$.

This work provides (i) the first measurement of α_s below the energy scale of τ mass, and (ii) discusses a new method determining α_s around B meson masses which provide comparable uncertainty with the PDG pre-averages from other fields. Future advancements including higher-order perturbative calculations, and precise measurements of $|V_{cb}|$, decay widths and spectra of D and B decays from BESIII, Belle II and upcoming Z factories, could enable these methods to determine α_s with higher precision, and boost the understanding of QCD in low energy region.

The detailed content of this work can be found on arXiv:2406.16119 and arXiv:2412.02480

Higgs-Mediated Repulsion in Cho-Maison Monopole-Antimonopole Pairs

Dan Zhu [1,2] , Xurong Chen [1,2] , Khai-Ming Wong [3]

1. Southern Center for Nuclear Science Theory, Institute of Modern Physics, Chinese Academy of Sciences

2. School of Nuclear Science and Technology, University of Chinese Academy of Sciences

3. School of Physics, Universiti Sains Malaysia

We confirm Higgs-mediated repulsive interactions in Cho-Maison monopole-antimonopole pair (MAP) configurations through the analysis of stress-energy tensor component T33Higgs. Numerical solutions reveal a critical sign reversal in r2sin θ T33Higgs in the asymptotic region, where repulsion originates dominantly from the Higgs kinetic term, overwhelming the Coulomb-like topological magnetic attraction. Systematic variation of the Higgs self-coupling β demonstrates that repulsion strength correlates inversely with Higgs mass: while prominent at β = 0, the repulsive region diminishes with increasing β and vanishes completely for β > 0.2. Crucially, this β-dependence confirms the conversion from long-range (∼1/r) to short-range (Yukawa-type) repulsion mediated by the Higgs sector. These results establish the Higgs field as the primary repulsive source stabilizing the MAP configurations at finite pole separation, counteracting electromagnetic attraction, and provide direct evidence for Higgs-generated repulsive forces in electroweak topological solitons.

Korea's Contributions to the CMS Endcap Timing Layer for the HL-LHC Upgrade

Chang-Seong Moon
Kyungpook National University

The High-Luminosity Large Hadron Collider (HL-LHC) will dramatically enhance the discovery potential for new physics by increasing the collision rate, resulting in up to 200 simultaneous interactions per bunch crossing. To ensure stable detector performance under these conditions, several CMS sub-detectors are being upgraded, including the MIP Timing Detector (MTD), which enables precise event timing with a resolution of 30–40 picoseconds to mitigate pileup effects.

The MTD consists of the Barrel Timing Layer (BTL) and the Endcap Timing Layer (ETL), each optimized for its specific environment with dedicated sensor and ASIC technologies. The ETL features two double-sided disks equipped with Low-Gain Avalanche Diode (LGAD) sensors and the Endcap Timing Readout Chip (ETROC), designed to operate under the challenging radiation and geometric conditions of the endcap region.

Korea has played a key role in the ETL project through extensive contributions in five main areas: LGAD sensor prototyping and validation, system testing with LGADs and ETROCs, LGAD wafer processing, bump bonding, and module assembly. These efforts are critical to the successful production and integration of ETL modules, which are currently in the pre-production phase with ongoing system validation and quality control activities.

Study of electron-positron annihilation into four pions within chiral effective field theory in the low energy region

Jiayu Zhou

Hunan University

In this paper, we employ chiral effective field theory to study the process of electron-positron annihilation into four pions in the low energy region within $E_{c.m.}\leq 0.6$ GeV. The prediction of the cross-section is obtained through $SU(3)$ chiral perturbation theory up to the next-to-leading order, which is smaller than the experimental data in the energy region [0.6-0.65] GeV, though the data has only a few points and poor statistics.

Then, the resonance chiral theory is applied to include the resonance contribution, with the lightest scalars and vectors written in the effective Lagrangians. A series of relevant decay widths and the masses of the vectors are studied to fix the unknown couplings.

The resonance contribution should be one order larger than that of the chiral perturbation theory but still one to two orders smaller than the data. The significant discrepancy urged the new experimental measurements to give more guidance. We also compute the leading order hadronic vacuum polarization contribution from the four pion channels to the anomalous magnetic moment of the muon, $(g-2)_\mu$. In the energy range from threshold up to 0.6 GeV within RChT, the contributions are $a_\mu=(0.6799\pm0.0618)\times10^{-16}$ and $a_\mu=(0.5973\pm0.0575)\times10^{-16}$ for the processes of $e^+e^-\to\pi^+\pi^+\pi^-\pi^-$, $\pi^0\pi^0\pi^+\pi^-$, respectively.