Chirality and Gauge Theories

JGU Mainz, Special lecture course [08.128.610]
Winter semester 2018/19

Lecturer: Dr. Felix Yu

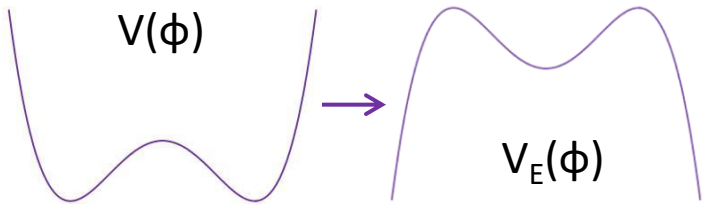
Time: Fridays (Oct. 19 to Feb. 15), 10 AM-12 PM (c.t.)
Place: Minkowski Room (Staudinger Weg 7, 05-119)

Anomalies (classically conserved quantities that are violated by quantum effects) are at the heart of some of the most beautiful and intricate aspects of quantum field theory. Phenomenologically, the absence of gauge anomalies in the Standard Model is the central reason that the number of quark generations matches the number of lepton generations. Anomalies also play a crucial role in the decay $\pi^0 \to \gamma\gamma$, the resolution of the η-η' puzzle in QCD spectroscopy, and the consistency of superstring constructions in D = 10 spacetime dimensions. Moreover, the interplay between chiral anomalies and the non-trivial vacuum structure of non-Abelian gauge theories reveals some deep aspects of quantum field theory where calculable non-perturbative effects are critical. These can be seen via instanton effects in determining the QCD vacuum (and the calculation of the η‘ mass), as well as the non-conservation of baryon and lepton number in the Standard Model at high temperatures via electroweak sphalerons.

The first part of this lecture series will present chiral anomalies in detail, focusing on both their formal aspects and phenomenological consequences. One additional lecture will focus on other types of anomalies in QFTs. The second part of the series will discuss topological effects in Yang-Mills theories, stationary solutions in classical and quantum field theory, their manifestations as instantons and sphalerons, and phenomenological applications such as the Θ-vacuum of QCD.

Attendees are expected to have basic knowledge of quantum field theory and the Standard Model of particle physics. Basic knowledge of topology would be beneficial but is not required. This course is not for academic credit.

$$\mathcal{A} = \partial^\mu j^5_\mu = \frac{e^2}{16\pi^2} F\tilde{F}$$



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