Summary: The superpotential in four-dimensional heterotic effective theories contains terms arising from holomorphic Chern-Simons invariants associated to the gauge and tangent bundles of the compactification geometry. These effects are crucial for a number of key features of the theory, including vacuum stability and moduli stabilization. Despite their importance, few tools exist in the literature to compute such effects in a given heterotic vacuum. In this work we present new techniques to explicitly determine holomorphic Chern-Simons invariants in heterotic string compactifications. The key technical ingredient in our computations are real bundle morphisms between the gauge and tangent bundles. We find that there are large classes of examples, beyond the standard embedding, where the Chern-Simons superpotential vanishes. We also provide explicit examples for non-flat bundles where it is non-vanishing and non-integer quantized, generalizing previous results for Wilson lines.

MSC:
83E30 String and superstring theories in gravitational theory
58J28 Eta-invariants, Chern-Simons invariants
81T60 Supersymmetric field theories in quantum mechanics

Keywords:
superstring vacua; differential and algebraic geometry; supersymmetric effective theories

Software:
Calabi-Yau database; CICY Quotients; PALP; Fermat.m

Full Text: DOI arXiv

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Edited by FIZ Karlsruhe, the European Mathematical Society and the Heidelberg Academy of Sciences and Humanities
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