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Particle on a torus knot: A toy model for Hodge theory

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Abstract: We investigate a system of particle constrained to move on a torus knot via the framework of superfield formalism and derive the off-shell nilpotent and absolutely anti-commuting (anti-)Becchi-Rouet-Stora-Tyutin (BRST) symmetries. Further, we demonstrate the existence of the off-shell nilpotent and absolutely anti-commuting (anti-) co-BRST symmetry transformations by the means of Lagrangian formulation. The anti-commutator of these aforementioned nilpotent and continuous symmetry transformations furnishes a symmetry - bosonic symmetry, which leaves the Lagrangian quasi-invariant. Moreover, we procure all the conserved charges - the generators of corresponding symmetry transformations in the theory. Finally, we show that the algebra satisfied by these continuous symmetries (and corresponding charges) is analogous to the algebra of the de Rham cohomological operators of differential geometry. Thus, we prove that the constrained system of particle on a torus knot provides an exciting toy model for Hodge theory, where the existing continuous symmetries capture a physical realization of differential operators at the algebraic level.

Session

Formal Theory

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