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Central Extensions, Derivations, and Automorphisms of Semi-Direct Sums of the Witt Algebra with its Intermediate Series Modules

Lie algebras formed via semi-direct sums of the Witt algebra $\mathcal{W} = \mathrm{Der}(\mathbb{C}[t, t^{-1}])$ and its modules have become increasingly prominent in both physics and mathematics in recent years. In this paper, we complete the study of (Leibniz) central extensions, derivations and automorphisms of the Lie algebras formed from the semi-direct sum of the Witt algebra and its indecomposable intermediate series modules (that is, graded modules with one-dimensional graded components). Our techniques exploit the internal grading of the Witt algebra, which can be applied to a wider class of graded Lie algebras.

Keywords: Witt algebra, Virasoro algebra, intermediate series module, tensor density module, central extension, derivation, automorphism, Lie algebra cohomology, Leibniz cohomology.

MSC: 17B40, 17B56; 17B65, 17B68.