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The Binary $\mathfrak{aff}(n|1)$-Invariant Differential Operators On Weighted Densities On The Superspace $\mathbb{R}^{1|n}$ And $\mathfrak{aff}(n|1)$-Relative Cohomology

Khaled Basdouri * Salem Omri † Wissal Swilah ‡

Abstract

We consider the $\mathfrak{aff}(n|1)-$module structure on the spaces of differential bilinear operators acting on the superspaces of weighted densities. We classify $\mathfrak{aff}(n|1)-$invariant binary differential operators acting on the spaces of weighted densities. This result allows us to compute the first $\mathfrak{aff}(n|1)-$relative differential cohomology of $\mathcal{K}(n)$ with coefficients in the superspace of linear differential operators acting on the superspaces of weighted densities.

Mathematics Subject Classification (2010). 17B56, 53D55, 58H15.
Key words : Affine Lie superalgebra, Differential Operators, Cohomology.

1 Introduction

Let $\mathfrak{vect}(1)$ be the Lie algebra of polynomial vector fields on $\mathbb{R}$. Consider the 1−parameter deformation of the $\mathfrak{vect}(1)-$action on $\mathbb{R}[x]$:

$$L^{\lambda}_{X\frac{d}{dx}}(f) = Xf' + \lambda X'f,$$

where $X, f \in \mathbb{R}[x]$ and $X' := \frac{dX}{dx}$. Denote by $\mathcal{F}_\lambda$ the $\mathfrak{vect}(1)-$module structure on $\mathbb{R}[x]$ defined by L^λ for a fixed λ. Geometrically, $\mathcal{F}_\lambda = \left\{ f dx^\lambda \mid f \in \mathbb{R}[x] \right\}$ is the space of polynomial weighted densities of weight $\lambda \in \mathbb{R}$. The space $\mathcal{F}_\lambda$ coincides with the space of vector fields, functions and differential 1−forms for $\lambda = -1$, 0 and 1, respectively.

Denote by $\mathrm{D}_{\lambda,\mu} := \mathrm{Hom}_{\mathrm{diff}}(\mathcal{F}_\lambda, \mathcal{F}_\mu)$ the $\mathfrak{vect}(1)-$module of linear differential operators with the natural $\mathfrak{vect}(1)-$action. Feigin and Fuchs [6] computed $\mathrm{H}^1_{\mathrm{diff}}(\mathfrak{vect}(1); \mathrm{D}_{\lambda,\mu})$, where $\mathrm{H}^*_{\mathrm{diff}}$ denotes the differential cohomology; that is, only cochains given by differential operators are considered. They showed that non-zero cohomology $\mathrm{H}^1_{\mathrm{diff}}(\mathfrak{vect}(1); \mathrm{D}_{\lambda,\mu})$ only appear for particular values of weights that we call *resonant* and which satisfy $\mu - \lambda \in \mathbb{N}$.

If we restrict ourselves to the Lie subalgebra of $\mathfrak{vect}(1)$ generated by $\{\frac{d}{dx}, x\frac{d}{dx}\}$, isomorphic to $\mathfrak{aff}(1)$, we get a family of infinite dimensional $\mathfrak{aff}(1)-$modules, still denoted $\mathcal{F}_\lambda$ and $\mathrm{D}_{\lambda,\mu}$.

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