

## Mathematics &gt; Commutative Algebra

# On the Rank of Multi-graded Differential Modules

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A  $\mathbb{Z}^d$ -graded differential  $R$ -module is a  $\mathbb{Z}^d$ -graded  $R$ -module equipped with an endomorphism,  $\delta$ , that squares to zero. For  $R=k[x_1, \dots, x_d]$ , this paper establishes a lower bound on the rank of such a differential module when the underlying  $R$ -module is free. We define the Betti number of a differential module and use it to show that when the homology  $H(D)=\ker(\delta)/\text{im}(\delta)$  of  $D$  is non-zero and finite dimensional over  $k$  then there is an inequality  $\text{rank}_R D \geq 2^d$ .

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