SEMINARIO DI GEOMETRIA E ALGEBRA

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Regular quantum commutative algebras

Abstract. Regular quantum commutative algebras were introduced by Regev and Seeman in 2005. Let R be an associative algebra over an algebraically closed field K of characteristic 0, and consider a decomposition into a direct sum of subspaces

$$\mathscr{R}: R = R_1 \oplus \cdots \oplus R_m.$$

We say that this decomposition is a *regular quantum commutative decomposition* if the following conditions are satisfied:

(1) For every $n \in \mathbb{N}$ and every $(i_1, \ldots, i_n) \in \{1, \ldots, m\}^n$, there exist elements $r_j \in R_{i_j}$ such that $r_1 \cdots r_n \neq 0$.

(2) For all $1 \leq i, j \leq m$, there exists a scalar $\theta(i, j) \in K^*$ (called a *quantum factor*) such that

$$r_i r_j = \theta(i, j) r_j r_i$$

for all $r_i \in R_i$ and $r_j \in R_j$.

If an associative algebra R admits such a decomposition, then R is called a *regular quantum commutative algebra*. These algebras play an important role in the study of polynomial identities. When the regular quantum decomposition of R arises from a grading by a finite abelian group G, we say that R is a G-graded regular algebra; in this case, the scalars $\theta(i, j)$ becomes a bicharacter of G. In this talk, we study regular quantum commutative algebras without assuming the existence of an underlying grading. First, we present results related to the Bahturin–Regev conjecture on the minimality of minimal regular quantum commutative decompositions and on the determinant of the regular decomposition matrix $\mathcal{M} = (\theta(i, j))_{i,j}$. Moreover, we provide a characterization of finite dimensional semisimple algebras that admit a regular quantum commutative decomposition in terms of the orders of their simple components.

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