ICM 1998, Berlin, Aug. 18–27

Abstracts of Short Communications and Posters

Section:

7. Lie Groups and Lie Algebras

1991 MS Classification: 16, 5, 18, 81

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Ringel-Hall algebras and quantum groups

Let A be a finite-dimensional hereditary algebra over a finite field. The Ringel - Hall algebra $\mathcal{H}(A)$ is a $\mathbb{Q}(v)$-vector space with basis the set of isoclasses $[M]$ of finite A-modules, with product $[M]\cdot[N] = v^{\langle M,N\rangle}[] \to \sum g^L_{M,N}[L]$, where $g^L_{M,N}$ is the filtration number of L by M and N, $\langle \underline{L}, -\rangle$ is the Euler form. Consider the composition algebra $\mathcal{C}(A)$, the subalgebra of $\mathcal{H}(A)$ generated by all simple modules. Works of C. M. Ringel and J. A. Green show that the generic version of $\mathcal{C}(A)$ is isomorphic to the positive quantum group U^+. If A is representation-finite (equivalently, $\mathcal{C}(A) = \mathcal{H}(A)$), then this isomorphism provides a basis of U^+. In affine case, properties of $\mathcal{C}(A)$ via the classification of representations will be presented.