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Categorification and Heisenberg doubles arising from towers of algebras

A tower of algebras is a graded algebra such that each graded piece is itself an algebra (with a different multiplication). Classic examples include the towers of group algebras of symmetric groups, Hecke algebras of type A, and nilcoxeter algebras. It is known that the Grothendieck groups of towers of algebras satisfying some natural conditions are Hopf algebras, with the product and coproduct coming from induction and restriction functors. We will discuss how certain induction and restriction functors on the category of modules over a tower of algebras categorify the so-called Heisenberg double of the Hopf algebra associated to that tower. In addition, we prove a Stone—von Neumann type theorem in this general setting. As special cases of our categorification theorem, we recover results of Geissinger, Zelevinsky, and others (for the case of symmetric groups, where the Heisenberg double is the infinite rank Heisenberg algebra) and Khovanov (for the case of nilcoxeter algebras, where the Heisenberg double is the Weyl algebra). For the tower of 0-Hecke algebras, we obtain an algebra that we call the quasi-Heisenberg algebra. As an application of our Stone—von Neumann type theorem in this case, we obtain a new, representation theoretic, proof of the fact that the algebra of quasisymmetric functions is free as a module over the algebra of symmetric functions. This is joint work with Oded Yacobi.