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Researh Plan

I am studying Cohomological Hall algebra and related topics.

Cohomological Hall algebra and its representation

Cohomological Hall algebra (CoHA for short) is the convolution algebra whose underlying vector spaces are given by appropriate cohomology theory of moduli stack of quiver representations. For a given quiver with potential, there is a cohomology theory which is associated with the homology given by the perverse sheaves of vanishing cycles of the potential. The resulting CoHA is called critical CoHA and it is closely related to the theory of Donaldson-Thomas invariant and its refinement. In a joint work with Kentaro Nagao, we are studying the construction of representation of critical CoHA on the (critical) homology of the moduli spaces of stable framed represetations of Jacobi algebra. We are also studying its reduction property of CoHA for quiver with potential and cut.

Positivity conjecture of quantum cluster algebras

In a joint work with Fan Qin, we have constructed a basis which includes the set of quantum cluster monomials and which have non-negative structure constants for acyclic quantum cluster algebras. Recently, the Laurent positivity conjecture for (classical) cluster algebras is solved by Lee and Schiffler, and also the quantum Laurent positivity for cluster algebras which arise from the graded quiver with potential is solved by Davison-Maulik-Schuermann-Szendroi using the purity of global section of the mixed Hodge modules of vanishing cycles. It would be intersting to study the construction of "restriction functor" , the relation to the "canonical decomposition" of cluster-tilting theory and the consturction of monoidal categorification of quantum cluster algebra in more generalities.

Generalization of quiver varieties

Geiß-Leclerc-Schröer introduced a generalization of path algebra and preprojetive algebra which is motivated by Hernandez-Leclerc's study of representation theory of untwisted quantum affine algebra. The generalized preprojective algebra also appear in the work of $\mathcal{N} = 2$ super symmetric gauge theory of non-simply laced gauge group by Cecotti-del Zotto. Also the special case of the generalized preprojective algebra has appeared in the work of Yamakawa studied in the moduli space of meromorphic connection on projective line with irregular singularity and related affine Weyl group action. In particular, we will generalize the theory of canonical bases and quiver varieties.