My research interests are in low dimensional topology, quantum algebra, and combinatorics. I have a particular interest in the theory of operads and the theory of invariants of knots and 3-manifolds.

(1) The LMO invariant is one famous notion in the theory of invariants of 3-manifolds. In my early work, I calculated the LMO invariant of lens space using formula by D. Bar-Natan and R. Lawrence, and find some pairs of lens spaces those are homotopy equivalent but have different values of the LMO invariant. In my another work, I gave a proof of the LMO conjecture which says that for any simply connected simple Lie group G, the LMO invariant of rational homology 3-spheres recovers the perturbative invariant. By Habiro-Le theorem, this implies that the LMO invariant is the universal quantum invariant of integral homology 3-spheres. It is conjectured that G evaluation of LMO invariant is captured to the trivial connection contribution to the quantum G invariant of rational homology 3-sphere. Actually, it is true for Seifert homology spheres and the contribution can be expressed as a matrix integral. In the case of G=U(N), Garoufalidis and Marino showed that U(N) evaluation of the LMO invariant of arbitrary rational homology 3-sphere can be always expressed as a matrix integral. In my recent work, I had the same result for G=O(2N),Sp(N). More recently, I have been studying a question that is just how much of the Gromov-Witten theory on the dual can be recovered from the LMO invariant. I want to explain this question using the language of operads.

(2) My recent research, partially related to (1), is to construct a invariant for tree tangles similar to the Kontsevich integral of knots and links. Each coefficient of the invariant is a morphism from the operad of tree tangles to the operad of Leibniz algebras. Moreover, the whole invariant has a rack structure.