

Research Talk: Resurgence, Quantum Modularity and Quantum Invariants

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The Witten-Reshetikhin-Turaev (WRT) quantum invariant of three-manifolds is the mathematical realization of the Chern-Simons partition function with compact gauge group. Inspired by the use of resurgence in physics, this invariant has been studied from the viewpoint of resurgence in recent years, and this study has led to many important discoveries. The use of resurgence in quantum Chern-Simons field theory was pioneered by Witten and Garoufalidis. This research greatly illuminated the interplay between Chern-Simons theory with compact gauge group and with complexified gauge group and how this interplay manifests itself in resurgence properties of the divergent series arising from perturbation theory. Furthermore, work of Gukov, Putrov and Mariño showed how resurgence connects the WRT quantum invariant to the BPS q -series invariant of Gukov, Pei, Putrov and Vafa (GPPV). The BPS q -series invariant is conjectured to categorify the WRT quantum invariant through the radial limit conjecture of GPPV, and to be a quantum modular form. In this talk, we consider the case where the three-manifold is a Seifert fibered homology sphere. We explain how the WRT quantum invariant determines the complex Chern-Simons invariants through resurgence, and we explain how a resurgence formula for the BPS q -series leads to a proof of the radial limit conjecture as well as a proof of quantum modularity. The former is based on joint work with Andersen, and the proof of quantum modularity is based on joint work in progress with Andersen, Han, Li, Sauzin and Sun.

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