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Combinatorial Topological Quantum Field Theories and Geometrical Constructions of Integers in Finite Group Representation Theory

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Topological quantum field theories (TQFTs) which have a simple physical formulation as lattice gauge theory with finite gauge group G admit elegant expressions for partition functions on closed higher genus Riemann surfaces. There are expressions for the partition functions in terms of the combinatorial counting of flat G-bundles and in terms of dimensions of irreducible representations (irreps). Consideration of the partition functions of these G-Flat-TQFTs across different genuses gives finite algorithms which start from group multiplications and yield the spectrum of dimensions of irreps. The input into the algorithms is formed by identities which generalise the classic formula for the order of a group as a sum of squares of the dimensions of irreps. Considering the partition functions of the G-Flat-TQFTs for surfaces with boundaries leads to the derivation of integrality properties of certain partial sums along columns of the character table of G. Analogous considerations starting from a topological field theory based
on the fusion ring of a finite group (denoted G-Fusion-TQFT) allows the proof of analogous integrality properties for partial sums along rows of the character table. These row-column relations between integrality properties of characters can be viewed as a mathematical reflection of a physical row-column duality between the G-flat TQFTs and the G-fusion TQFTs.
The talk is based on the papers :
1. https://arxiv.org/abs/2106.05598: Integrality, duality, and finiteness in combinatoric topological strings ;
2. https://arxiv.org/abs/2304.10217: Row-Column duality and combinatorial topological strings ;
3. https://arxiv.org/abs/2204.02266: Combinatoric topological string theories and group theory algorithms.

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