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*Topological Expansions and Applications*

We will review recent developments in random matrix theory related with the enumeration of maps, which are connected graphs embedded into a surface.

In the seventies, Brézin, Itzykson, Parisi and Zuber, following an idea of 't Hooft, showed that Gaussian matrix integrals expand formally as generating functions for the enumeration of maps sorted by their genus. This follows from Gaussian calculus (or Feynman diagrams). We shall prove that these 'topological' expansions are, under appropriate assumptions, also asymptotic expansion as the size of the matrices goes to infinity. This in particular justifies the use of Gaussian matrix integrals in physics to enumerate these graphs.

We will show that such 'topological' expansions generalize to other matrices such as unitary matrices following the Haar measure (even though Gaussian calculus does not hold anymore). We will finally discuss some applications in combinatorics and operator algebras.