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From random matrices, through magic squares, to the multiplicative chaos

In 2004, motivated by connections of random matrix theory to number theory, Diaconis and Gamburd showed a fascinating connection between the enumeration problem of magic squares (squares filled integers with row and column sum constraints) and the moments of the 'secular coefficients' of random matrices, when the size of the matrix tends to infinity. These are the coefficients in the monomial expansion of a characteristic polynomial, or equivalently, the elementary symmetric polynomials of the eigenvalues of this random matrix.

It turns out that this characteristic polynomial has a limit, when the matrix size tends to infinity. It converges to a random fractal, the holomorphic multiplicative chaos. We describe this process on the unit circle, and show how it can be connected even more strongly to random matrices, and how magic square combinatorics are a type of 'signature' of this holomorphic multiplicative chaos. We'll review some open questions about these objects, and discuss some links between this and other stochastic processes such as the Gaussian multiplicative chaos, the 'circular beta-ensemble' and random multiplicative function.