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Diffusion of Large Matrices

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In this talk, we study large matrices undergoing additive or multiplicative random dynamics. Besides purely theoretical appeal, such models have been proven very useful in various problems spanning from quantum mechanics to machine learning. Most of the traditional applications of random matrices correspond to the 'static case', when one is only interested in spectral properties of certain ensembles, and not in the properties of evolution of such ensembles as a function of some external parameter. We name this parameter generically as 'time', however its meaning is much richer: "time" could be the length of mesoscopic wire, area of the string, depth of the neural network, strength of noise in signal-plus-noise statistical models etc. The resulting diffusion equations have a priori unexpected features – they are nonlinear and exhibit phenomena of shock waves, they also, in the case of non-symmetric matrices, couple nontrivially the dynamics of eigenvalues to the dynamics of eigenvectors. We provide several examples of such phenomena in various branches of science.