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Stochastically forced fluid equations: Transfer between scales and ergodicity.

Consider the 2 dimensional Navier-stokes equation on a periodic domain which describes the time evolution of a incompressible fluid. If left in isolation, energy will leave the system and solution will decay to zero. Hence to obtain a non trivial longtime statistics, we need to inject energy into the system. We choose to do this by adding a random forcing to the system. We wish that this perturbation disturb the structure of the solution "as little as possible". Since we are interested in how the nonlinearity organizes the energy, we will inject the randomness at a certain spatial scale and study how it moves to other scales. This will involve understanding the algebra which describes how the nonlinearity propagates randomness.

From a probabilistic point of view, such stochastic partial differential equations (SPDEs) give rise to very interesting class of Markov processes in infinite dimensions. The generators of such SPDE are very degenerate. Understanding their longtime behavior will require understanding hypoelliptic operators in infinite diminutions. We will need a generalisation of Hormander's sum of squares theorem for SPDEs and a version of Harris' ergodic theorem adapted to the infinite dimensional setting. I will start from the beginning and empathize what is typically true in such infinite dimensional settings, highlighting the principle complications in the ergodic theory of SPDEs. Similar ideas can be applied to stochastic delay equations. (Received April 16, 2008)