Universality Classes for General Random Matrix Flows

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We consider matrix-valued processes described as solutions to stochastic differential equations of very general form. We study the family of the empirical measure-valued processes constructed for the corresponding eigenvalues. We show that the family indexed by the size of the matrix is tight under very mild assumptions on the coefficients of the initial SDE. We characterize the limiting distributions of its sub-sequences as solutions to the integro-differential equation. We use the result to study universality classes of random matrix flows. These generalize the classical results related to Dyson Brownian motion and squared Bessel particle systems, but even in these cases we show new phenomenons as the lack of uniqueness of solution and existence of the generalized Marchenko-Pastur distributions supported on the real line. Assuming the uniqueness of the solution to the integro-differential equation we characterize the limiting process as a free diffusion solving free SDE. This is based on a joint work with José Luis Pérez.