Probability Distribution of the Free Energy of the Continuum Directed Random Polymer in $1 + 1$ Dimensions

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Abstract. We consider a continuum model for directed polymers in a quenched (space-time white noise) random environment. The partition function for this model is the expectation over paths, sampled as a Brownian Bridge, of the exponential of the path integral (Hamiltonian) through this random field. This function gives a solution to the well-poised stochastic heat equation with multiplicative noise and, by employing the Hopf-Cole transform, can be considered to give a solution to the stochastic Burgers equation and the KPZ equation. We give an exact formula for the probability distribution for the one-point fluctuations of the logarithm of this solution (the free energy). Taking temperature to zero for the polymer model (or equivalently time to infinity in the stochastic heat equation) we recover the $F_2$ distribution of Tracy and Widom, as had been conjectured in both math and physics literature to be the case.

Our methods rely heavily on recent exact formulas related to the integrable structure of the asymmetric simple exclusion process (ASEP) given by Tracy and Widom. The free energy probability distributions we encounter appear to be new and seem to have certain nice integrable properties which we continue to explore.

This talk is based on ongoing work with Jeremy Quastel and Gideon Amir of the University of Toronto.