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Department of Theoretical Physics

THE QUANTUM SPACETIME SEMINAR SERIES

Renormalization group flows in disordered field theories.

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Date: Oct 22, 2018
Time: 11:45 am
Venue: A-304, TIFR

We will analyze the renormalization group (RG) flow of field theories with quenched disorder, in which the couplings vary randomly in space. We analyze both classical (Euclidean) disorder and quantum disorder, emphasizing general properties rather than specific cases. The RG flow of the disorder-averaged theories takes place in the space of their coupling constants and also in the space of distributions for the disordered couplings, and the two mix together. We write down a generalization of the Callan-Symanzik equation for the flow of disorder-averaged correlation functions. We find that local operators can mix with the response of the theory to local changes in the disorder distribution, and that the generalized Callan-Symanzik equation mixes the disorder averages of several different correlation functions. For classical disorder we show that this can lead to new types of anomalous dimensions and to logarithmic behavior at fixed points. For quantum disorder we find that the RG flow always generates a rescaling of time relative to space, which at a fixed point generically leads to Lifshitz scaling. The dynamical scaling exponent z behaves as an anomalous dimension and we compute it at leading order in perturbation theory in the disorder for a general theory. We also find in quantum disorder that local operators mix with non-local (in time) operators under the RG, and that there are critical exponents associated with the disorder distribution that have not previously been discussed.

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