Title:  Statistical field theory for active matter

Abstract:

Statistical field theory is a cornerstone of soft matter physics. For example 'Model B' is a stochastic, dynamical phi-4 field theory describing diffusive phase separation in binary systems such as colloidal suspensions. It respects detailed balance and hence Time Reversal Symmetry (TRS); in steady state it yields the familiar Landau-Ginzburg theory of phase transitions. Active systems, such as swarms of microbes or active colloids, do not respect detailed balance because their steady states are powered by a supply of food, fuel, or light. I will survey our work on adding to Model B minimal terms that break TRS to represent the effects of activity. Consequences include the arrest of structure on finite lengthscales caused by a reversal of the Ostwald-ripening process. A crucial tool for these studies is the 'informatic entropy production' (IEPR) found by comparing the statistical weights of forward and time-reversed field trajectories. This quantifies the extent to which microscopic irreversibility remains visible in the coarse-grained dynamics. Close to the critical point for phase separation, active terms are irrelevant in the RG sense: our models lie in the same universality class as Model B. Yet the IEPR points to nontrivial irreversibility governed by a new critical exponent.