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Correlated Cluster Algorithms

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Cluster algorithms are Monte Carlo algorithms that provide efficient non-local updates of the configurations. They can avoid critical slowing down when approaching a second-order phase transition and solve severe sign problems in well-tailored cases. The clusters group degrees of freedom that can be updated independently of one another. While highly efficient, the range of models that can be simulated this way is limited. In this talk, I will introduce an extension of the cluster algorithm approach referred to as Correlated Cluster Algorithms. This new method allows for simulation of models where clusters cannot be updated independently of one another. If the interdependence of the clusters can be encoded in a tree structure, configuration updates can be chosen using a dynamic programming approach. Models that can be simulated with the new approach include interacting particles in the canonical ensemble and 1+1D gauge theories in the Hamiltonian formulation, which are subjected to Gauss's law. Additionally, the inclusion of topological θ-terms does not offer any challenge to this approach.

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