Contribution ID: **49** Type: **Poster presentation**

Order parameters from persistent homology in non-Abelian lattice gauge theory

Finding order parameters for the detection of critical phenomena and self-similar behavior in and out of equilibrium is a challenging endeavour in non-Abelian gauge theories. Tailored to detect topological structures in noisy data and accompanied by stability and limit theorems, persistent homology allows for the construction of sensible and sensitive observables. Based on state-of-the-art hybrid Monte Carlo simulations of SU(2) lattice gauge theory I will show how the persistent homology of filtrations by chromoelectric and -magnetic fields, topological densities and Polyakov loops can be used to gauge-invariantly and without cooling algorithms uncover interpretable features of the confinement-deconfinement phase transition. In classical-statistical simulations far from equilibrium persistent homology observables reveal clear self-similar scaling related to a nonthermal fixed point, demonstrating the universality of scaling beyond correlation functions. Our results showcase the extensive versatility of persistent homology in non-Abelian gauge theories.

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Session Classification: Poster session