

Cosmic Strings and Kinks on Lattice

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In the field theories, topological defects are objects with particle-like properties like stability and localised energy density. They arise from the solutions of the systems equations of motion, which differ topologically from the vacuum solution. It is believed that certain kind of defects were formed in the phase transitions of early Universe as a consequence of spontaneously broken symmetry. It is notable that defects appear in the classical systems, and no quantum field theory treatment is needed.

In the most cases systems with defects cannot be solved analytically due to the nonlinear nature of the system. Often one then resorts to numerical studies. This can be done in terms of lattice field theory, where one replaces continuous spacetime by discrete lattice, and system can thus be described with Hamiltonian formalism with finite degrees of freedom. Hamiltonian of the simple system is discretised just by replacing integration by summations and derivations by finite differences. Yet if system contains gauge symmetries, the discretisation procedure is rather nontrivial. The only requirement for discretisation is that the discrete system approaches to continuum one as one goes to the limit of zero lattice spacing and infinite volume.

Since the symmetries play essential role in the field theories, one wants that the discrete system on lattice respects as many symmetries of its continuum counterpart as possible. Time translation and gauge invariance can be implemented exactly on a lattice. Yet obviously translation and Lorentz invariance are not exact on a lattice, since lattice is only invariant modulo lattice spacing in these transformations. This has observable and rather fatal consequences as momentum of the system is not conserved due to the broken translational invariance, and moving defects slow down, and system radiates due to the broken Lorentz invariance.

In this poster we present a graphical survey to the lives of simple topological defects, the ϕ^4 -kinks and cosmic strings on lattice, supported by awesome animations.