

Topological solitons are non-perturbative, localized objects which carry a non-zero value of a topological index. Topological solitons are important object in fundamental theories (see for example, Yang-Mills instantons, monopoles and sphalerons in the standard model) which penetrate the non-perturbative regime of the underlying fundamental quantum theories. Furthermore, they vastly exist in many models with applications to various branches of theoretical as well as experimental physics - from (1+1) dimensions (as kinks and domain walls in BEC or liquid crystals), through vortices in the Abelian Higgs model of a superconductor, planar Skyrmion in magnetic materials or cosmic strings, to (3+1) dimensional Skyrmions which provide a unified, effective description of baryons, atomic nuclei and nuclear matter with application to neutron stars. These are only a very few examples of almost infinity ways in which topological solitons enter in nature.

Obviously, a detailed **understanding of interactions** of solitons is crucial for both theoretical and applicational reasons. It can explain non only individual fate of interaction soliton but also allow us for computation of the annihilation rates or observation of possible deviations from the Kibble-Zurek mechanism of soliton production in a phase transition which can have some impact on the existence of cosmic defects. Moreover, it may lead to various practical applications.

The scattering of solitons and, especially, their annihilation, is a very complicated process which usually does not lead to solvable structures. There are several factors which contribute to the complexity of the process. First of all, each soliton participating in the collision acts with a static force on the other participants, deforming their shapes. These deformations can also lead to the excitation of some internal modes, storing temporally some energy. The excited modes then can interact with the solitons and, as a consequence, influence the dynamics. Finally, radiation can be produced in the scattering, which should be taken into account as it may have a nontrivial impact on the solitons, like, e.g., soliton creation or negative radiation pressure. All these types of interactions (by **the static force, the internal modes** and **radiation**) mix with each other, rendering any analytical treatment extremely difficult. As a consequence, there is basically **no understanding of soliton-antisoliton (SAS) processes** in various classical field theories in any dimensions (as for example kinks in (1+1) dimensions, vortices and Skyrmions in higher dimensions etc.).

The aim of the project is to provide a **universal and systematic method for the complete understanding dynamics of topological solitons**, i.e., extended, nonperturbative solutions carrying a topological charge, in non-integrable field theories in any dimensional space time. This includes: (1) classical multi-soliton and anti-soliton processes as scatterings, annihilations and creations etc.; (2) quantum processes as vibrations contributing to the quantum binding energies.