SBREW 2025

Monday, 8 September 2025 - Thursday, 11 September 2025

Opava, Czech Republic

Book of Abstracts

Contents

1

Dislocations and crystallization dynamics of chiral soliton lattices

Author: Minoru Eto[1]

Co-authors: Kentaro Nishimura [2]; Muneto Nitta [3]

[1] *Yamagata university*

[2] *Niigata university*

[3] *Keio University*

Corresponding Author: meto@sci.kj.yamagata-u.ac.jp

Dislocations, as topological defects in crystal lattices, are fundamental to understanding plasticity in materials. Similar periodic structures also arise in continuum field theories, such as chiral soliton lattices (CSLs), which appear in condensed matter systems like chiral magnets and in high-energy contexts such as quantum chromodynamics in strong magnetic field or under rapid rotation. This work investigates whether dislocations can dynamically form within such emergent CSLs. The chiral sine-Gordon model, reduced from the aforementioned examples by certain truncations, is useful to determine the ground state but it cannot describe time evolution, lacks dynamical formation or leads to singular dislocations, because its equations of motion do not contain a topological term. We propose a field-theoretical model including the topological term coupled to external fields resolving these issues by modifying the topological term so it affects the dynamics. Using numerical simulations, we study the real-time formation of CSLs in two and three spatial dimensions. In 2D, edge dislocations emerge spontaneously, guiding soliton growth and later annihilating to leave a stable CSL. In 3D, both edge and screw dislocations form; the latter exhibits helical structure influenced by the external field. We find stable double helical screw dislocations looking like a double helix staircase or DNA. We then demonstrate the formation of helical dislocations and analyze how the external field strength affects CSL density and formation speed. Our results provide a novel theoretical framework for understanding dislocations in solitonic structures, connecting high-energy field theory with materials science phenomena.

2

TBA

Author: Filip Blaschke[1]

[1] *Silesian University in Opava*

Corresponding Author: filip.blaschke@physics.slu.cz

To be revealed …

3

On the realization of spin in field configurations of the SO(3) and SU(2) groups instead of in the su(2) algebra

Author: Manfried Faber[1]

[1] *Techn. Univ. Wien*

Corresponding Author: faber@kph.tuwien.ac.at

This is possible because the su(2) algebra only reflects some properties of the SO(3) and SU(2) groups. I show that in a realization of spin-1/2 configurations as topological solitons with long-range Coulomb interaction, pairs of such solitons can be coupled to spin-0 and spin-1 states. Numerical calculations of these configurations show that the spin-1 states have slightly higher energy than the spin-0 states.

4

Landau-de Gennes-Skyrme model to recreate electromagnetism for liquid crystal-like quantized topological charges

Author: Jarosław Duda[1]

[1] *Jagiellonian University*

Corresponding Author: jaroslaw.duda@uj.edu.pl

For liquid crystals there are experimentally recreated long-range e.g. Coulomb-like interactions between topological charges. Combining liquid crystal Landau-de Gennes model having Higgs-like potential of SO(3) vacuum, with 4-th order Skyrme term, we get effective Coulomb potential with Gauss law counting topological charge, then electromagnetism from Lorentz invariance. Regularization of singularities leads to low distance/high energy deformation of Coulomb in agreement with the running coupling effect.
There also appear topological vortices in agreement with QCD flux tubes/quark strings, allowing fractional charge xcitations for quarks, with conflict between them of asymptotically linear energy –recreating QCD Cornell potential. Baryon-like structures get structural tendency for positive core, which for neutron must be compensated –explaining why it is heavier than proton, or why deuteron has electric quadrupole moment. These quark strings seem also crucial for nuclear binding, including halo nucleons (arXiv:2108.07896).

Slides: https://www.dropbox.com/scl/fi/p1ydy45sngzw8ubk1thhx/liquid-crystal-particles.pdf?rlkey=n4202c6bjntcfo2l

5

Multidimensional integrability from contact geometry

Author: Artur Sergyeyev[1]

[1] *Silesian University in Opava*

Corresponding Author: artur.sergyeyev@math.slu.cz

We show in a constructive fashion that, contrary to the long-held belief, there is plenty of nonlinear partial differential systems in four independent variables that are integrable in the sense of soliton theory beyond a few previously known examples like (anti-)self-dual Yang–Mills equations or (anti-)self-dual vacuum Einstein equations.

Namely, using a novel class of Lax pairs related to contact geometry, we present infinitely many new examples of integrable systems in four independent variables.

For further details, please see A. Sergyeyev, Multidimensional integrable systems from contact geometry. *Bol. Soc. Mat. Mex.* **31** (2025), art. 26, arXiv:2501.04474

6

Witten Effect and Polarizability of the Magnetic Monopole

Author: Maximilian Bachmaier[1]

[1] *University of Munich and Max-Planck-Institute for Physics*

Corresponding Author: maximilian.bachmaier@physik.uni-muenchen.de

Using quantum arguments, Witten proposed that a magnetic monopole acquires electric charge in a theta vacuum. In a formulation where the theta vacua of a gauge theory are described by the vacua of a massless Chern-Simons 3-form, we showed that the Witten effect can already be captured at the level of effective classical equations of motion. Beyond this, we numerically demonstrated that a magnetic monopole exhibits polarizability when placed in a constant background electric field. In this talk, I will give a brief introduction to the 3-form formulation of theta vacua and present our numerical results on both the Witten effect and the polarizability of magnetic monopoles.

7

Towards a Construction of Algebro-Geometric Solutions for Integrable Vortex Equations

Authors: Atsushi Nakamula[1]; Kaoru Miyamoto[1]

[1] *Japan*

Corresponding Author: kaoru@hiroshima-u.ac.jp

The integrable vortex equations, which were originally motivated by models of superconductivity, can be explicitly solved using Liouville's equation. While integrable vortices are known to exist on surfaces of non-zero genus (e.g., a torus), concrete vortex solutions and detailed studies of their analytic properties on higher-genus surfaces remain limited. Within the theory of integrable systems, the finite-gap (or algebro-geometric) method provides a powerful technique for constructing explicit solutions on Riemann surfaces of genus g. In this talk, we apply the finite-gap method to Liouville' s equation and construct a finite-gap vortex solution, as a step towards a systematic construction of integrable vortices on higher-genus surfaces.

8

Standard Model on a domain wall brane

Author: Masato Arai[1]

Co-author: Nobuchika Okada [2]

[1] *Yamagata University*

[2] *University of Alabama*

Corresponding Author: arai@sci.kj.yamagata-u.ac.jp

We investigate phenomenological features in Standard Model on a domain world brane in five-dimensional space-time, which is constructed in arXiv: 1802.06649. In this model, the gauge fields non-minimally couple to the Higgs field, by which the gauge fields are localized on the four-dimensional space-time. At the same time, this coupling gives rise to a new interaction such as Zhh. This contributes to the process e^-e^+ ->Zh, which occurs in Standard Model at tree level, and the cross

section deviates from one of Standard Model. We evaluate this deviation in the future International Linear Collider.

9

Soliton quantization-finite domain wall tension

Author: hengyuan guo[1]

Co-authors: Baiyang zhang [2]; Jarah Evslin [3]; hui liu [4]

[1] *Sun Yat-sen university/Pisa university*

[2] *Henan University*

[3] *Institute of modern physics*

[4] *Yerevan Physics Institute*

Corresponding Author: guohy57@mail.sysu.edu.cn

In 1+1 dimensions, soliton quantum states are usually described by coherent states, but as Coleman noted in his 1975 Erice lectures, this approach fails in higher dimensions because of divergent energy densities. We show that even in 1+1 dimensions the proper states are deformations of coherent states. In the 3+1-dimensional $\phi 4$ double-well model, the leading deformation—a squeeze—already removes the one-loop divergence in the domain wall soliton's energy density

10

Cluster Dynamics and Wormholes

When an important part of the dynamics of multiple particles, or fields, is described in terms of a reduced dynamics with just a few collective coordinates, then the reduced dynamics is generally characterised by a curved configuration space together with a potential function. Applications include soliton/antisoliton dynamics, coupling of soliton dynamics to internal shape modes, and oscillon dynamics. This talk will focus on nuclear dynamics for nuclei that are clusters of alpha particles. In Neon-20, an important subset of quantum states arises from dynamics on a configuration space that is a spatial wormhole, as discussed in papers written in collaboration with M. Dunajski and (very recently) R. Bai.

11

Oscillons and bubbles in Q-ball dynamics

12

TBA

13

TBA

14

On topological character of calorons

Calorons are finite action solutions to (anti-)selfdual Yang-Mills equations on partially compact space S^1 times R^3.

These objects can be constructed as a periodic array of instantons in R^4 naively, however, the topological character of calorons is quite different from that of instantons. In this talk, we focus on this difference and re-examine the prior research on the topological character of calorons.

15

Resonance windows and energy exchange mechanism in double long-range kink-antikink interactions

This talk concerns long-range kinks, topological solitons in 1+1 dimensions. Because of their highly interactive nature, studying their dynamics becomes complex and requires specialized numerical methods to initiate the dynamics. We will mainly focus on the extreme cases with double long-range kinks, which are long-range in both tails. We search for resonance windows and possible energy exchange mechanisms in their dynamics.