



# 第86回2024年度第2回

広島大学極限宇宙研究拠点

Hiroshima University CORE-U Seminar

Title:

Phase diagram of QCD matter with magnetic field:  
domain-wall Skyrmion chain in chiral soliton lattice

Speaker:

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Date : 18<sup>th</sup>.April.2024 (Thu) (10:00-11:30)

2024年4月18日(木) (10:00-11:30)

Place: 広島大学理学部E203大会議室 (対面形式)

Room E203, Faculty of Science, Hiroshima University

Abstract: See the back side of the poster

Language: 日本語 (Japanese)

スライド (Slides in English)

ZOOM Link

<https://us04web.zoom.us/j/77159513950?pwd=cv15eYhQpFf1RnoQwUt5x0FEnMViGO.1>

ミーティング ID: 771 5951 3950 パスコード: yvgik5

共同セミナーは対面のみとします。出欠はセミナー終了時にE203で取ります。

The participation of collaboration seminar will be checked after the talk at the room E203

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## Abstract:

- QCD matter in strong magnetic field exhibits a rich phase structure. In the presence of an external magnetic field, the chiral Lagrangian for two flavors is accompanied by the Wess-Zumino-Witten (WZW) term containing an anomalous coupling of the neutral pion  $\pi_0$  to the magnetic field via the chiral anomaly. Due to this term, the ground state is inhomogeneous in the form of either chiral soliton lattice (CSL), an array of solitons in the direction of magnetic field, or domain-wall Skyrmion (DWSk) phase in which Skyrmons supported by  $\pi_3[\text{SU}(2)] \simeq \mathbb{Z}$  appear inside the solitons as topological lumps supported by  $\pi_2(S^2) \simeq \mathbb{Z}$  in the effective worldvolume theory of the soliton. In this paper, we determine the phase boundary between the CSL and DWSk phases beyond the single-soliton approximation, within the leading order of chiral perturbation theory. To this end, we explore a domain-wall Skyrmion chain in multiple soliton configurations. First, we construct the effective theory of the CSL by the moduli approximation, and obtain the  $\mathbb{C}P^1$  model or  $O(3)$  model, gauged by a background electromagnetic gauge field, with two kinds of topological terms coming from the WZW term: one is the topological lump charge in 2+1 dimensional worldvolume and the other is a topological term counting the soliton number. Topological lumps in the 2+1 dimensional worldvolume theory are superconducting rings and their sizes are constrained by the flux quantization condition. The negative energy condition of the lumps yields the phase boundary between the CSL and DWSk phases. We find that a large region inside the CSL is occupied by the DWSk phase, and that the CSL remains metastable in the DWSk phase in the vicinity of the phase boundary.