2026 Workshop on
Pure and Applied Mathematics

Venue: 310, 자연과학대학1호관 (D14), CNU, Gwangju

Date: 27-28 July 2026

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Organizing committee

설윤창 (CNU)
김준하 (Ajou)
문보라 (Yonsei)
이상훈 (PNU)

Timetable

Monday, 27 of July

개인당 25분이 주어집니다. (20분 발표 + 5분 질문)

12:50–13:00	**Welcome remarks**	
13:00–13:25 Chair: 설윤창	문보라 (연세대)	Quantitative hydrodynamic limit of the Chern–Simons–Higgs system
13:25–13:50	문정우 (중앙대)	On a compact Einstein type manifold with Riemannian foliations
13:50–14:15	김준하 (아주대)	Uniqueness of alpha-SQG in critical Hölder space
14:15–14:40	박영웅 (중앙대)	Electrostatic interpretation of zeros of pseudo-ultraspherical polynomials
14:40-15:00	**Coffee Break**	
15:00–15:25 Chair: 임하빈	박재민 (숙명여대)	Hausdorff Dimension of Singular Vectors: From Weights to Fractals
15:25–15:50	박향동 (KAIST)	A Two-Phase Free Boundary Problem for Axisymmetric Subsonic Euler Flows with Contact Discontinuities
15:50–16:15	안수현 (아주대)	Conformalized monitoring of histogram-valued data
16:15–16:40	유광민 (Brookhaven Lab)	Quantum Utility on Near-Term Quantum Computers
16:40-17:00	**Coffee Break (**단체사진촬영**)**	
17:00–17:25 Chair: 문보라	이상훈 (부산대)	Hawking mass and rigidity of three-manifolds with boundary
17:25–17:50	장준영 (중앙대)	Extending the time interval of validity of the long-wave approximation
17:50–18:15	정우정 (경희대)	Quantum Error Correction
18:15-20:30	**Dinner** ‘마실’	

Tuesday, 28 of July

개인당 25분이 주어집니다. (20분 발표 + 5분 질문)

9:30-11:30 Chair: 김준하	설윤창, 임하빈 문보라, 정우정	Panel Discussions (Future Directions and Vision for the Workshop)
11:30–13:30	**Lunch** ’어나더 키친’	
13:30–14:00	**Closing Remarks**	

List of Abstracts – Talks

Monday 27th

Quantitative hydrodynamic limit of the Chern–Simons–Higgs system

문보라 13:00–13:25

Yonsei University

We study the hydrodynamic limit of the Chern–Simons–Higgs system, a relativistic gauge field model involving the Chern–Simons interaction. We introduce a single scaling parameter capturing both the non-relativistic (infinite speed of light) and semi-classical (vanishing Planck constant) regimes. This unified scaling allows us to justify the simultaneous non-relativistic and semi-classical limit, while retaining the nontrivial influence of the Chern–Simons gauge structure. Using a modulated energy method, we establish quantitative convergence rates toward the corresponding compressible Euler–Chern–Simons system as the scaling parameter tends to zero.

On a compact Einstein type manifold with Riemannian foliations

문정우 13:25–13:50

Chung-Ang University

We investigate a compact Einstein type manifold whose potential vector field generates a Riemannian foliation. In particular, we prove necessary conditions for such a manifold to be taut and to have a splitting property. Additionally, some properties of taut Riemannian foliations on a compact almost Ricci solitons and a compact Einstein manifolds are provided.

Uniqueness of alpha-SQG in critical Hʹolder space

김준하 13:50–14:15

Ajou University

In this talk we establish uniqueness for alpha-SQG equations in the Hʹolder space C^α. This is the critical space in the sense that existence of solutions is not guaranteed, while the flow map barely remains well-defined. We prove that whenever a C^α Lagrangian solution starting from given initial data exists, it must be unique within this class, by estimating the L^∞-norm of the difference between two flow maps.

Electrostatic interpretation of zeros of pseudo-ultraspherical polynomials

박영웅 14:15–14:40

Chung-Ang University

We consider the case where a finite number of unit charges are distributed along a line and a negative charge $-\alpha$ is fixed outside the line. Assuming that the electric force between charges is inversely proportional to the distance, we show that the energy minimizing distribution of the unit charges coincides with the zeros of the pseudo-ultraspherical polynomials. We also investigate the degenerate case where a one-parameter family of energy minimizing distribution exists.

Hausdorff Dimension of Singular Vectors: From Weights to Fractals

박재민 15:00–15:25

Sookmyung Women's University

Dirichlet's theorem guarantees simultaneous rational approximations to every vector $(x \in \mathbb{R}^d)$. A vector is singular if the Dirichlet bound can be improved by an arbitrarily small multiplicative constant at all sufficiently large scales. After briefly recalling singular and weighted singular vectors, I will present a joint result with Taehyeong Kim: for a weight $(w = (w_1, \dots, w_d))$ with $(w_1 \geq \cdots \geq w_d > 0)$ and $(\sum_i w_i = 1)$,

$$\dim_H \mathrm{Sing}(w) \geq d - \frac{1}{1 + w_1}.$$

This recovers the Cheung–Chevallier formula for equal weights and is sharp in dimension two by the theorem of Liao–Shi–Solan–Tamam. I will sketch the self-affine fractal construction and higher-dimensional lattice counting behind the lower bound. I will then turn to singular vectors constrained to fractal sets and describe ongoing joint work on the Cantor-square problem, emphasizing the new counting and dimension-theoretic difficulties created by the fractal restriction.

A Two-Phase Free Boundary Problem for Axisymmetric Subsonic Euler Flows with Contact Discontinuities

박향동 15:25–15:50

KAIST

We study a two-phase free boundary problem for the three-dimensional steady compressible Euler equations with a contact discontinuity in an infinitely long circular cylinder. The contact discontinuity separates an axisymmetric rotational subsonic flow from an axisymmetric potential subsonic flow, where both phases are unknown. Using a Helmholtz decomposition, we reformulate the problem and develop a coupled iteration scheme that simultaneously determines the free boundary and the two flow fields. We establish the global existence of solutions and their downstream asymptotic behavior.

Conformalized monitoring of histogram-valued data

안수현 15:50–16:15

Ajou University

Histogram-valued data arise naturally in applications where observations are represented by distributions rather than single numerical measurements. Monitoring such data is challenging because conventional control charts are primarily designed for scalar or vector observations and often lack finite-sample performance guarantees for distributional data. This study proposes a conformal prediction-based monitoring approach for histogram-valued data, providing finite-sample Type I error control under exchangeability. By combining conformal prediction with support vector data description (SVDD) and a Wasserstein distance-based kernel, the proposed method effectively captures distributional characteristics of histogram-valued observations while maintaining rigorous false alarm control. Simulation studies and a real-data application demonstrate that the proposed method achieves accurate Type I error control and competitive detection power, with stable performance under moderate contamination.

Quantum Utility on Near-Term Quantum Computers

유광민 16:15–16:40

Brookhaven National Laboratory

Recent advancements in quantum computing have marked a transition from demonstrating "Quantum Utility" and "Quantum Advantage" where quantum devices deliver practical value for real-world scientific and industrial applications. However, near-term quantum computers (NTQCs) operate in a noise-dominant regime, heavily constrained by hardware limitations, limited circuit expressiveness, and compiling overheads. To overcome these bottlenecks, this presentation proposes a "Full-stack Co-design" paradigm that synergistically integrates quantum algorithms, compilers, hardware architecture, and noise-aware circuit design. To demonstrate the feasibility of this hardware- and noise-aware approach, we investigate the time evolution of complex Hamiltonian systems, such as the anisotropic Heisenberg model and J1-J2 spin chains, optimizing Trotterization circuit structures to drastically minimize CNOT gate counts and circuit depth. Furthermore, we employ a suite of quantum error mitigation (QEM) techniques, including Dynamical Decoupling (DD) to suppress crosstalk and decoherence in idle qubits, and Pauli Twirling (PT) to transform coherent errors into stochastic noise. For scaling up to more complex physical systems like the Gross-Neveu model, a lattice gauge theory for strong interactions, we introduce the Localized Diagonal Operator Approximation (LDOA) method, which maps multi-qubit diagonal operators into hardware-efficient circuits and enables reliable simulations of up to 100+ sites on real quantum processors, such as IBM’s heavy-hex architecture. Additionally, this talk explores the necessity of geometry- and movement-aware compilation strategies for alternative hardware platforms, such as neutral-atom systems. Ultimately, we emphasize that the critical need for noise- and hardware-aware algorithm design persists not only in the noisy NTQC era but also as we transition into early Fault-Tolerant Quantum Computing (FTQC) with logical qubits, and that this utility-scale, full-stack co-design approach serves as a crucial blueprint for realizing practical and reliable quantum simulation.

Hawking mass and rigidity of three-manifolds with boundary

이상훈 17:00–17:25

Pusan National University

In this talk, we explore rigidity phenomena for three-manifolds with boundary through the Hawking mass. We begin by introducing the Hawking mass and its geometric significance. We then review rigidity results for closed three-manifolds obtained via the Hawking mass. Finally, we present recent extensions of these rigidity results to the setting of three-manifolds with boundary.

Extending the time interval of validity of the long-wave approximation

장준영

Chung-Ang University

17:25–17:50

The water wave problem is a free-boundary problem describing the motion of a sea with a free surface. But the full water wave equation is difficult to use directly for the analysis of specific phenomena or for long-time numerical simulations. For this reason, one often replaces the full water wave equation by simpler asymptotic models and then rigorously justifies their validity through multi-scaling analysis. However, most existing justification results require high regularity of the initial data and are valid only on limited time intervals, which leaves a gap between the mathematical theory and the practical use of water wave models. In this talk, I will present a method for extending the temporal validity by studying the KdV limit of the BBM and Boussinesq equations. This talk is based on joint work with Prof. Younghun Hong (Chung-Ang Univ.).

Quantum Error Correction

정우정

Kyunghee University

17:50–18:15

양자 컴퓨팅은 소인수분해, 양자 시뮬레이션, 최적화 문제 등에서 기존의 고전 컴퓨터를 뛰어넘는 계산 능력을 제공할 것으로 기대되고 있다. 그러나 최근의 연구들은 실질적인 Quantum Advantage를 달성하기까지 여전히 해결해야 할 여러 과제가 존재함을 보여주고 있다. 특히 현재의 NISQ(Noisy Intermediate-Scale Quantum) 기술과 실용적인 Fault-tolerant Quantum Computing 사이에는 상당한 기술적 간극이 존재하며, 이를 극복하는 것이 양자 컴퓨팅 연구의 중요한 목표로 여겨지고 있다. 이러한 간극을 만드는 가장 큰 원인 중 하나는 양자 오류 정정(Quantum Error Correction, QEC)의 막대한 자원 비용이다. 양자 시스템은 외부 환경과의 상호작용에 매우 취약하기 때문에, 신뢰성 있는 계산을 수행하기 위해서는 계산 과정에서 발생하는 오류를 지속적으로 검출하고 수정해야 한다. 따라서 실용적인 양자 알고리즘의 구현에는 단순히 많은 수의 물리 큐비트가 필요한 것이 아니라, 높은 수준의 Fault Tolerance를 보장하기 위한 효율적인 오류 정정 기법이 필수적으로 요구된다. 대표적인 예가 Shor 알고리즘이다. Shor 알고리즘은 큰 수의 소인수분해를 효율적으로 수행할 수 있는 양자 알고리즘으로 잘 알려져 있지만, 실제 구현을 위해서는 매우 낮은 논리 오류율과 방대한 수의 양자 게이트 연산이 필요하다. 기존의 자원 추정에 따르면 이를 구현하기 위해 수백만 개 이상의 물리 큐비트가 요구될 것으로 예상되었으며, 이는 양자 오류 정정 과정에서 발생하는 높은 자원 비용에 기인한다. 최근 발표된「Shor's Algorithm is Possible with as Few as 10,000 Reconfigurable Atomic Qubits」는 이러한 자원 문제를 획기적으로 완화할 수 있는 가능성을 제시하였다. 이 연구에서는 재구성 가능한 원자 배열(Reconfigurable Atom Arrays)을 이용하여 초고속 양자 오류 정정을 수행함으로써, 필요한 물리 큐비트 수를 크게 감소시키고 약 10,000개의 원자 큐비트만으로도 Shor 알고리즘의 구현이 가능함을 보였다. 본 발표에서는 먼저 Fault-tolerant Quantum Computing에서 양자 오류 정정이 왜 핵심적인 문제인지를 살펴보고, 재구성 가능한 원자 배열을 이용한 초고속 오류 정정 기법의 핵심 아이디어를 소개한다. 마지막으로 이러한 접근이 Shor 알고리즘의 자원 요구량을 어떻게 크게 감소시켰는지와 그 의미를 논의하고자 한다.

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