# Schedule

	17-Jun	18-Jun	19-Jun	
8:55-9:00	Welcome session			
9:00-10:00	Xiaomeng XU	Sergei GUKOV	Sergei GUKOV	Mini-courses
10:00-10:30	Group Photo	Tea Break / free discussion	Tea Break / free discussion	
10:30-11:30	Jie GU	Xiaomeng XU	Jie GU	
11:30-12:00	Free discussion	Free discussion	Free discussion	
12:00-13:00	Lunch	Lunch	Lunch	
13:00-14:00	Midday rest	Midday rest	Midday rest	
14:00-15:00	Qiongling LI	David SAUZIN	Hee-Joong CHUNG	Research talks
15:00-15:30	Tea Break / free discussion	Tea Break / free discussion	Tea Break / free discussion	
15:30-16:30	Campbell WHEELER	Emanuel SCHEIDEGGER	Dylan ALLEGRETTI	
16:30-16:40	Short break	Short break	Short break	
16:40-17:40	Hongfei SHU	Maximilian SCHWICK	Bin ZHANG	
17:40-18:00	Free discussion	Free discussion	Free discussion	
18:00-19:00	Banquet	Dinner	Dinner	

Resurgence theory lies at the crossroad of mathematics and mathematical physics. It was founded in 1980 in the context of dynamical systems but has become a fixture in the past decade's mathematics/physics research literature, with a burst of activity in applications ranging from ordinary differential equations on the complex domain, wall-crossing phenomena in geometry and topology, and exact WKB method to deformation quantization and Topological Quantum Field Theory.

We will organize a workshop on Resurgence Theory in Mathematical Physics from 17<sup>th</sup> to 19<sup>th</sup> June 2024 at the Chern Institute of Mathematics, Nankai University in Tianjin, China.

The workshop aims to provide an introduction to these advanced topics (mainly gauge theory and topological string theory), survey the recent developments, investigate the open problems and conjectures, and stimulate new collaborations between participants from different research fields. The topics will be resurgence theory, Wall-crossing structures, holomorphic Floer theory, Exact WKB theory, gauge theory and topological string theory. Along with the research talks, there will be three two-part mini courses.

Invited Speakers: Dylan Allegretti, Tsinghua U. Hee-Joong Chung, Jeju National U. Jie Gu, Southeast U. Sergei Gukov, Caltech Qiongling Li, Nankai U. Emanuel Scheidegger, Peking U. Maximilian Schwick, Geneva U. Hongfei Shu, Zhengzhou U. Campbell Wheeler, IHES Xiaomeng Xu, Peking U. Bin Zhang, Sichuan U. David Sauzin, Capital Normal U./IMCCE

The organizing committee

Yong Li (Tsinghua University, Beijing), David Sauzin (Capital Normal University, Beijing, on leave from IMCCE, Paris), Shanzhong Sun (Capital Normal University, Beijing)

### Xiaomeng XU(徐晓濛)

1. Title: The explicit expression of Stokes matrices at a second order pole

Abstract: This talk first gives an introduction to the Stokes phenomenon of a linear system of ordinary differential equations and its associated nonlinear isomonodromy deformation equation. By solving a Riemann-Hilbert problem, it then gives the explicit expression of the Stokes matrices via the long time asymptotics of the isomonodromy equation. The explicit formula can help us to study the WKB approximation of the Stokes matrices. It is based on joint works with Qian Tang, and with Anton Alekseev, Andrew Neitzke and Yan Zhou.

2. Title: Quantum groups and canonical basis arising from the Stokes phenomnon and WKB approximation

Abstract: This talk first shows that the quantum Stokes matrices of the quantum differential equation around a second order pole gives rise to representations of quantum groups. Based on the solution to the Riemann-Hilbert problem (as in the first talk), it then shows that the WKB approximation of the quantum Stokes matrices lead to the crystal structures in the representations.

## Jie GU(顾杰)

Title: Resurgence in QM and SQFT

Abstract: Resurgence theory has important applications in quantum mechanics (QM) and supersymmetric quantum field theory (SQFT). In QM, the exact WKB method based on resurgence techniques allows derivation of exact quantisation conditions of energy spectrum and full energy trans-series. In SQFT, non-perturbative corrections to free energy and Wilson loops can be uncovered by resurgence considerations. These two themes in QM and SQFT are then surprisingly connected through the BPS invariants of the SQFT.

### Qiongling LI(李琼玲)

Title: Harmonic metrics on Higgs bundles over non-compact surfaces

Abstract: For a Higgs bundle over a compact Riemann surface of genus at least 2, the Hitchin-Kobayashi correspondence says the existence of a harmonic metric is equivalent to the polystability of the Higgs bundle. In this talk, we discuss some recent progress on the existence and uniqueness of harmonic metrics on Higgs bundles over general non-compact Riemann surfaces. This is joint work with Takuro Mochizuki.

## Campbell Wheeler

#### Title: Resurgence and state integrals

Abstract: I will discuss a new proof of resurgence of the asymptotic series of the Faddeev dilogarithm and how a similar method can be used to prove resurgence of asymptotic series associated to simple state integrals. This is based on work in progress with Veronica Fantini.

## Hongfei SHU(束红非)

Title: How Bethe ansatz works for non-quantum integrable models : TBA equations and exact WKB analysis

Abstract: The Bethe ansatz provides a powerful method for exactly solving the quantum integrable models. Over the past decades, it has been found that the Bethe ansatz also emerges in various apparently non-quantum integrable models, and provides amazing power to solve these models. In this talk, I will provide an overview on how thermodynamic Bethe ansatz (TBA) appears within the framework of exact WKB analysis, particularly in the context of the Schrödinger equation.

## Sergei GUKOV

Title: Black swans and going to the other side with resurgent analysis.

#### David SAUZIN

Title: Resurgent transseries completions for partial theta series

Abstract: I will review our previous work with Li Han, Yong Li and Shanzhong Sun about the resurgence-summability aspects of partial theta series associated with arbitrary periodic sequences, and in particular the action of modular transformations on them. Here, the variable was confined to the upper half-plane, except for the quantum modularity phenomenon in which certain functions can be analytically continued to the right or to the left of an arbitrary rational point. Then I will explain recent developments concerning the functions of (z,\bar z) defined in the lower half-plane that appear naturally in that context: they enjoy similar quantum modularity relations and appear as a new kind of transseries completion.

Emanuel SCHEIDEGGER TBA

### Maximilian SCHWICK

Title: Resurgence at Finite and at Large N.

Abstract: In physics, resurgence methods find a fruitful playground because of the natural appearance of divergent power series. There are two commonly used types of expansion:

Firstly assuming that the number N of constituents of a theory is large one expands in 1/N.

Secondly one can expand around the coupling constant g being small.

In this context a natural question is the relation between those two power series and their resurgent properties. I will outline how the non perturbative contributions of the two series are intimately related and illustrate this relation in matrix models and topological strings.

Hee-Joong Chung Title : Resurgent analysis for some 3-manifold invariants Abstract : In this talk, we discuss resurgent analysis on the Chern-Simons partition function for some 3-manifolds when the gauge group is  $G_C = SL(2, C)$ . We review some aspects of analytically continued Chern-Simons partition function and the role of abelian flat connection. Then we discuss resurgent analysis on the Chern-Simons partition function for a certain infinite family of Seifert manifolds and Seifert knots and see that the information of non-abelian flat connections can be captured by the abelian flat connection. We also discuss how homological blocks can be obtained from resurgent analysis.

## Dylan Allegretti

#### Title: Asymptotics of spectral coordinates

Abstract: I will begin by describing a collection of functions, called spectral coordinates, that one can associate to a quadratic differential on a Riemann surface. I will then describe recent work in which I prove a conjecture of Gaiotto, Moore, and Neitzke on the asymptotic behavior of these spectral coordinates. I will also discuss an interesting limit, called the conformal limit, in which the spectral coordinates can be obtained as Borel sums of certain formal series appearing in exact WKB analysis.

#### Bin ZHANG

## Title: The renormalization of Feynman amplitudes

Abstract: In this talk, we will discuss the renormalization of Feynman amplitudes on Riemannian manifolds. The goal is to get invariants for Riemannian manifolds by Feynman rule rigorously. Our main result is that the spectral regularization of an Feynman amplitude is a meromorphic germ of distribution with linear poles, whose proof depends on the desingularization of the product of heat kernels. Based on this, we can renormalize the Feynman amplitudes to obtain invariants for the Riemannian manifolds systematically. This is joint work with Viet Dang.