

# The second conference on Lie theory (NKU-NYU Abu Dhabi-SUSTech)

March 25-28, 2026

## Schedule of Lectures

### March 26th (Thursday)

Time	Speaker	Title	Host
9:00-9:20	Opening Ceremony 开幕式		
9:20-10:00	Mikhail Kochetov	Group Gradings on Algebras	Vyacheslav Futorny
10:00-10:30	Tea Break 茶歇		
10:30-11:10	Hengjia Zhang 张恒嘉	Oscillator Representations on $sl(n)$ and $o(n)$ and Their Associated Varieties	Xianqian Guo 郭向前
11:10-11:50	Bayarmagnai Gombodorj	Generalized Whittaker Functions on $SU(2,2)$	
12:00	Lunch 午餐		
14:30-15:10	Ning Li 李宁	Structure and Applications of Degenerate Principal Series	Di Wang 王迪
15:10-15:50	Xingpeng Liu 刘兴鹏	On Dimension Growth of Non-Restricted Irreducible Modules over Quantum Groups at Roots of Unity	
15:50-16:20	Tea Break 茶歇		
16:20-17:00	Xu Gao 高煦	Universal Enveloping Algebras of Vertex Operator Algebras	Hengjia Zhang 张恒嘉

## March 27th (Friday)

Time	Speaker	Title	Host
9:00-9:20	Group Photo 合影		
9:20-10:00	Yunhe Sheng 生云鹤	Actions of Monoidal Categories and Representations of Cartan Type Lie Algebras	Shaoqiang Deng 邓少强
10:00-10:40	Qing Wang 王清	A Duality Between the Parafermion Vertex Algebras of $L_k(\mathfrak{osp}(1 2))$ at the Critical Level and $N=4$ Superconformal Vertex Algebra	
10:40-11:10	Tea Break 茶歇		
11:10-11:50	Kang Lu 陆康	Drinfeld Presentation of Twisted Yangians and Applications	Yan Wang 王艳
12:00	Lunch 午餐		
14:30-15:10	Shizhuo Yu 于世卓	Decorated Polyubles, Poisson Homogeneous Spaces and Multi-Flag Varieties	Honglian Zhang 张红莲
15:10-15:50	Santanu Tantubay	Simple Whittaker Modules for W-Type Cartan Lie Superalgebras	
15:50-16:20	Tea Break 茶歇		
16:20-17:00	Joao Fernando Schwarz	Algebras of Invariant Differential Operators	Zhenyu Zhou 周振宇
18:00	Dinner 晚餐		

## March 28th (Saturday)

Time	Speaker	Title	Host
9:20-10:00	Bakhrom Omirov	Cohomological Rigidity of Solvable Lie Algebras of Maximal Rank	Yongzhi Luan
10:00-10:40	Guowu Meng 孟国武	Jordan Algebra and Generalized Kepler Problems	栾永志
10:40-11:10	Tea Break 茶歇		
11:10-11:50	Iryna Kashuba	Zigzag-like Algebras and Representation Type of Jordan Algebras	Haibo Chen 陈海波
12:00	Lunch 午餐		
14:30-17:00	Free Discussion 自由讨论		
18:00	Dinner 晚餐		

# Abstracts

**Speaker:** Xu Gao 高煦 (Tongji University)

**Title:** Universal Enveloping Algebras of Vertex Operator Algebras

**Abstract:** In classical Lie theory, the universal enveloping algebra  $U(\mathfrak{g})$  is the central engine of representation theory. For Vertex Operator Algebras (VOAs), however, experts traditionally bypass the full enveloping algebra  $\mathcal{U}(V)$  in favor of its finite-dimensional shadow, the Zhu algebra  $A(V)$ . This is because VOA operations inherently involve infinite series, equipping  $\mathcal{U}(V)$  with a linear topology that has historically been difficult to control. In this talk, I will report on recent progress in the study of  $\mathcal{U}(V)$  (and its relatives) under the modern framework of almost-canonically seminormed rings. By using such seminorms, we are able to elegantly reproduce many classical results in VOA and twisted representations in this generality. Furthermore, I will focus on the "Strong Identity Condition", which arises from the algebraic formulation of the sewing of conformal blocks by Damiani, Gibney, and Krashen. I will characterize this condition in terms of Morita equivalence, expansion of unity, and projectivity. I will conclude by some interesting applications.

**Speaker:** Bayarmagnai Gombodorj (National University of Mongolia)

**Title:** Generalized Whittaker Functions on  $SU(2,2)$

**Abstract:** This talk addresses the construction of Whittaker functions for the principal series representations of  $SU(2,2)$ . We analyze the holonomic system of differential equations associated with higher-dimensional minimal K-types and derive explicit solutions for specific classes of these functions.

**Speaker:** Iryna Kashuba (Southern University of Science and Technology)

**Title:** Zigzag-like algebras and representation type of Jordan algebras

**Abstract:** We generalize the Huerfano and Khovanov notion of zigzag algebras in order to determine a representation type of special representations of Jordan algebras with radical square zero. This is joint with V. Bekkert and V. Serganova.

**Speaker:** Mikhail Kochetov (Memorial University of Newfoundland)

**Title:** Group Gradings on Algebras

**Abstract:** Let  $A$  be an algebra (not necessarily associative) and  $G$  a group. A  $G$ -grading on  $A$  is a family of subspaces  $\{A_g\}_{g \in G}$  such that  $A = \bigoplus_{g \in G} A_g$  and  $A_g A_h \subset A_{gh}$  for all  $g, h \in G$ . Given  $A$ , one can try to find all possible gradings on  $A$  by various groups, up to a suitable equivalence relation. Group gradings have been extensively studied for many important algebras, including simple finite-dimensional associative, Lie and Jordan algebras.

In this talk, I will review the possible settings of the classification problem for gradings and survey some of the old and new classification results as well as the methods that were used to

obtain them.

**Speaker:** Ning Li 李宁 (Nankai University)

**Title:** Structure and Applications of Degenerate Principal Series

**Abstract:** Degenerate principal series representations, obtained by parabolic induction from characters on Levi components of maximal parabolic subgroups, play a pivotal role in harmonic analysis and representation theory. The intricate structure of these representations, particularly their subquotients and composition series, has been extensively studied. They are also intimately connected with theta correspondence in the sense that theta lifts of trivial representations can be embedded into them. In this talk, I will introduce the basic concepts of degenerate principal series and their interplay with the local theta correspondence. Furthermore, we will explore the relation between the algebraic structure of these representations and the theory of intertwining operators.

**Speaker:** Xingpeng Liu 刘兴鹏 (Southern University of Science and Technology)

**Title:** On Dimension Growth of Non-Restricted Irreducible Modules over Quantum Groups at Roots of Unity

**Abstract:** In this talk, I will examine the dimensional growth patterns of irreducible representations for De Concini–Kac quantum groups as the order of the root of unity increases. These representations exhibit polynomial growth in the order of the root of unity, where the polynomial degree aligns with the Gelfand–Kirillov dimension of the corresponding irreducible highest weight module at generic  $q$ . We further characterize the minimal non-trivial growth rate and explicitly construct highest weight representations achieving this rate for types A, B, and C. As an application, we demonstrate that quantum cuspidal modules (at generic  $q$ ) can only exist if the underlying semisimple Lie algebra has simple components of type A, B, or C—revealing a key distinction from the classical case. The talk is based on joint work with Vyacheslav Futorny.

**Speaker:** Kang Lu 陆康 (Southern University of Science and Technology)

**Title:** Drinfeld Presentation of Twisted Yangians and Applications

**Abstract:** In recent joint work with Weiqiang Wang and Weinan Zhang, we have obtained Drinfeld-type current presentations for twisted Yangians of type AI and beyond. These presentations are realized through Gauss decomposition and the degeneration of affine quantum groups. In this talk, I will discuss recent progress in the study of these twisted Yangians ( $i$ Yangians) and their applications. Key topics include their coideal structure, their shifted generalizations, and their connections to finite  $W$ -algebras of classical types. This talk is based on joint works with Yung-Ning Peng, Lukas Tappeiner, Lewis Topley, Weiqiang Wang and Weinan Zhang.

**Speaker:** Guowu Meng 孟国武 (Hong Kong University of Science and Technology)

**Title:** Jordan Algebra and Generalized Kepler Problems

**Abstract:** The main message of this talk is that the mathematical essence of oscillator and Kepler problems is captured by formally real simple Jordan algebras. I will also outline the relevant aspects of Lie theory that enter a general theory of integrable (both classical and quantum) models based on these algebras.

**Speaker:** Bakhrom Omirov (Harbin Institute of Technology)

**Title:** Cohomological Rigidity of Solvable Lie Algebras of Maximal Rank

**Abstract:** The study of the second cohomology group of a Lie algebra with coefficients in the adjoint module lies at the intersection of several central themes in Lie theory, including cohomological algebra, deformation theory, the geometry of the variety of Lie algebra laws, and the extensions. The deformation theory introduced by Gerstenhaber for associative algebras was later adapted to the context of Lie algebras in the foundational work of Nijenhuis and Richardson. Within this framework, the cohomology group,  $H^2(L, L)$  acquires a natural interpretation as the space governing infinitesimal deformations of the Lie algebra  $L$ . A second and equally fundamental connection arises from the geometry of the algebraic variety of Lie structures. In the present talk we discuss on the second cohomology group with coefficients in the adjoint module for a class of solvable Lie algebras  $N \rtimes T$  that arise as maximal solvable extensions of nilpotent Lie algebras  $N$  of maximal rank. Under suitable structural assumptions on the root system determined by the action of a maximal torus  $T$  on  $N$ , we obtain sufficient conditions for the cohomological rigidity of  $N \rtimes T$ . Conversely, we identify explicit configurations of roots that force the second cohomology group to be non-trivial, thereby producing broad families of solvable Lie algebras that are not cohomologically rigid. Our results extend the classical sufficient conditions of Leger and Luks, and they provide a unified and computationally effective framework for determining the cohomological rigidity of a wide class of solvable Lie algebras, including several known results.

**Speaker:** Joao Fernando Schwarz (Southern University of Science and Technology)

**Title:** Algebras of Invariant Differential Operators

**Abstract:** Fixed rings of differential operators, their structure and representation theories have been studied in many instances by many authors, as G. Schwarz, I. Musson, etc. The work of this lecturer focus on the case we have fixed rings under the action of finite groups. In this case powerful structural results about the generators of the invariants are available, and with this information one can obtain strong results about their structure and representations. We will discuss the analogues of Chevalley-Shephard-Todd Theorem and Noether's Problem for the Weyl algebra, and study categories of Harish-Chandra and holonomic modules, with some conjectures relating them. Some of the results to be discussed are joint work with Vyacheslav Futorny.

**Speaker:** Yunhe Sheng 生云鹤 (Jilin University)

**Title:** Actions of Monoidal Categories and Representations of Cartan Type Lie Algebras

**Abstract:** Using crossed homomorphisms, we show that the category of weak representations (respectively admissible representations) of Lie–Rinehart algebras (respectively Leibniz pairs) is a left module category over the monoidal category of representations of Lie algebras. In particular, the corresponding bifunctor of monoidal categories is established to give new weak representations (respectively admissible representations) of Lie–Rinehart algebras (respectively Leibniz pairs). This generalises and unifies various existing constructions of representations of many Lie algebras by using this new bifunctor. We construct some crossed homomorphisms in different situations and use our actions of monoidal categories to recover some known constructions of representations of various Lie algebras and to obtain new representations for generalised Witt algebras and their Lie subalgebras. The cohomology theory of crossed homomorphisms between Lie algebras is introduced and used to study linear deformations of crossed homomorphisms.

**Speaker:** Santanu Tantubay (Southern University of Science and Technology)

**Title:** Simple Whittaker Modules for W-Type Cartan Lie Superalgebras

**Abstract:** Whittaker modules play a central role in the representation theory of Lie (super)algebras. In this talk, we will discuss about Whittaker modules for the Lie superalgebra  $W_{m,n}$  of vector fields on the superspace  $C^{m|n}$ . For any non-singular  $a \in C^m$ , we establish an equivalence between the block  $\Omega_{W_{m,n}}^a$  of the category of  $(AW)_{m,n}$ -Whittaker modules with finite-dimensional Whittaker subspaces and the category of finite-dimensional modules over the Lie subsuperalgebra  $T_{m,n}$  of  $(AW)_{m,n}$  (equivalently, over  $\mathfrak{gl}(m, n)$ ). Applying a covering technique, we classify the simple objects in  $\Omega_{W_{m,n}}^a$ : every simple non-singular Whittaker  $W_{m,n}$ -module is isomorphic to a simple subquotient of the tensor module  $T(A_a, V)$ , where  $V$  is a finite-dimensional simple  $\mathfrak{gl}(m, n)$ -module. This provides a complete classification, building on prior work on tensor modules over Witt superalgebras.

**Speaker:** Qing Wang 王清 (Xiamen University)

**Title:** A Duality Between the Parafermion Vertex Algebras of  $L_k(\mathfrak{osp}(1|2))$  at the Critical Level and  $N=4$  Superconformal Vertex Algebra

**Abstract:** In this talk, we present a duality between the parafermion vertex algebras of  $L_k(\mathfrak{osp}(1|2))$  at the critical level and  $N=4$  superconformal vertex algebra. As an application, we classify the irreducible ordinary modules of  $L_{\frac{3}{2}}(\mathfrak{osp}(1|2))$  and irreducible  $L_{\frac{3}{2}}(\mathfrak{osp}(1|2))$ -modules in the category  $\mathcal{O}$  and the category  $\mathcal{R}$  which includes relaxed highest weight modules. This is a joint work with Drazen Adamovic.

**Speaker:** Shizhuo Yu 于世卓 (Nankai University)

**Title:** Decorated Polyubles, Poisson Homogeneous Spaces and Multi-Flag Varieties

**Abstract:** The polyuble, as defined by Fock and Rosly, can be regarded as the  $n$ -th power of a given Manin triple. This construction plays an important role in Poisson geometry and mathematical physics. In this talk, we will introduce the construction of decorated polyubles associated with decorated Young diagrams, along with their combinatorial and Poisson-geometric interpretation.

**Speaker:** Hengjia Zhang 张恒嘉 (Nankai University)

**Title:** Oscillator Representations on  $\mathfrak{sl}(n)$  and  $\mathfrak{o}(n)$  and Their Associated Varieties

**Abstract:** Associated varieties are fundamental geometric invariants in the study of infinite-dimensional representations of semisimple Lie algebras. Luo and Xu constructed a large family of infinite-dimensional irreducible representations of special linear Lie algebras and orthogonal Lie algebras by applying Fourier transforms on the natural oscillator representations. In this talk, we will focus on the associated varieties of these modules. We will describe their explicit structure and their concrete connections with determinantal varieties, Pfaffian varieties, and Grassmannians. To conclude, we will highlight the significance of this work.