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Membership of Academic Societies:
The Mathematical Society of Japan

Research Interest:

- Representation Theory
- Algebraic Geometry
- Mathematical Physics

Research Summary:

My research areas are representation theory and algebraic geometry, in particular the topics related to mathematical physics and special functions.

My interest in algebraic geometry is mainly on the derived category of sheaves on algebraic varieties. Two keywords may be named: Fourier-Mukai transforms and Bridgeland stability conditions. On these topics, I have co-authored papers [3] and [9].

My interest in representation theory is mainly on quantum algebras, in particular quantum groups, Hall algebras and vertex algebras. In [1], we investigated the quantum integrable system associated to Macdonald symmetric functions using representation theory of $\mathfrak{gl}_1$ quantum toroidal algebra (also called the Ding-Iohara-Miki algebra).

Since then, I have been studying the Macdonald polynomials, the family of q-orthogonal polynomials associated to each affine root system. In the collaboration [7] with the doctor student Kohei Yamaguchi-san, we studied the parameter specialization of Koornwinder polynomials, the Macdonald polynomials associated to $(C_n^\vee, C_n)$ affine root system, and gave some classification and applications. In [8], we studied the bispectral Macdonald-Koornwinder functions and the parameter specialization.

As an intersection of algebraic geometry and representation theory, I have been studying geometric aspects of vertex algebras. In [5], I introduced the gluing construction of vertex algebras of class S in the derived setting, using the derived symplectic/Poisson geometry. In [6], I introduced an analogue of the canonical Li filtration of a vertex algebra for an arbitrary SUSY vertex algebra, and relate the representation theory of superconformal vertex algebras to the Poisson geometry of the associated superschemes.

Recently, I collaborated with the master student Yusuke Nishinaka-san [4] to establish the algebraic operad encoding the structure of SUSY vertex algebras, and with Masamune Hattori-san [2] to introduce the dynamical Ding-Iohara algebroids which unify the elliptic quantum groups and Ding-Iohara quantum algebras.

Major Publications:

[1] B. Feigin, K. Hashizume, A. Hoshino, J. Shiraishi, S. Yanagida, *A commutative algebra on degenerate* $\mathbb{CP}^1$ *and Macdonald polynomials*, J. Math. Phys. **50** (2009), no. 9, 095215, 42 pp.

[2] M. Hattori, S. Yanagida, *A dynamical analogue of Ding-Iohara quantum algebras*, preprint (2022), arXiv:2210.02777.

[3] H. Minamide, S. Yanagida, K. Yoshioka, *The wall-crossing behavior for Bridgeland's stability conditions on abelian and K3 surfaces*, J. Reine Angew. Math. **735** (2018), 1–107.
[4] Y. Nishinaka, S. Yanagida, *Algebraic operad of SUSY vertex algebra*, preprint (2022), arXiv:2209.14617.
[5] S. Yanagida, *Derived gluing construction of chiral algebras*, Lett. Math. Phys. **111** (2021), Article no. 51, 103pp.
[6] S. Yanagida, *Li filtrations of SUSY vertex algebras*, Lett. Math. Phys., **112** (2022), Article no. 103, 77pp.
[7] S. Yanagida, K. Yamaguchi, *Specializing Koornwinder polynomials to Macdonald polynomials of type B, C, D and BC*, J. Algebraic Combin. (2022), online published, 56pp.
[8] S. Yanagida, K. Yamaguchi, *A review of rank one bispectral correspondence of quantum affine KZ equations and Macdonald-type eigenvalue problems*, preprint (2022), arXiv:2211.13671.
[9] S. Yanagida, K. Yoshioka, *Semi-homogeneous sheaves, Fourier-Mukai transforms and moduli of stable sheaves on abelian surfaces*, J. Reine Angew. Math. **684** (2013), 31–86.

Education and Appointments:

2012 Ph.D. Mathematics at Kobe University
2012 JSPS PD at RIMS, Kyoto University
2012 Assistant Professor, RIMS, Kyoto University
2016 Associate Professor, Nagoya University

Message to Prospective Students:

Undergraduate students interested in algebraic geometry or (algebraic/geometric) representation theory will be welcomed. The reading seminar will be on standard texts such as the textbooks 1,2 and 3.

I also welcome graduate students who are willing to study Bridgeland stability conditions and related topics, or geometric representation theory of quantum algebras. For examples of particular topics, please see the books 4, 5 and 6 below.

1. R. Hartshorne, *Algebraic Geometry*, Graduate Texts in Mathematics **52**, Springer (1977).
2. T. Tanisaki, *Lie algebras and quantum groups* (in Japanese), Kyoritsu-syuppan (2002).
3. Y. Yamada, *Introduction to conformal field theory* (in Japanese), Baifukan (2006).
4. D. Huybrechts, *Fourier-Mukai transforms in algebraic geometry*, Oxford Univ. Press (2006).
5. D. Huybrechts, M. Lehn, *The geometry of moduli spaces of sheaves*, Cambridge University Press (2010).
6. E. Frenkel, D. Ben-Zvi, *Vertex algebras and algebraic curves*, 2nd edition, Mathematical Surveys and Monographs **88**, American Mathematical Society (2004).