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Research Interest:

- Algebraic Geometry
- Calabi-Yau varieties and Fano varieties
- Derived categories

Research Summary:

The following are classical methods to describe a space.

(A) Use equations.

(B) Use parameters.

An algebraic variety is a space that can be described as the common zeros of several polynomials. Algebraic geometry is the study of algebraic varieties. Algebraic varieties are, by definition, the subject of research based on the method (A). In algebraic geometry, the method (B) is also effective in some cases. When points of an algebraic variety M are parametrized by particular mathematical objects, M is called a moduli space. I have studied the geometry of K3 surfaces, irreducible holomorphic symplectic manifolds and Fano varieites from the point of view of algebraic geometry and moduli theory. Using the theory of derived categories of coherent sheaves in addition to the classical methods of algebraic geometry and moduli theory, I want to find interesting properties of algebraic varieties.

A K3 surface is a 2-dimensional Calabi-Yau manifold, which is a fundamental object among algebraic surfaces. A K3 surface may have not only a description as an algebraic varieties, but also a description as a moduli space. Hence, K3 surfaces can be studied using both methods (A) and (B). The notion of irreducible holomorphic symplectic manifolds is a generalization of K3 surfaces. Examples of higher dimensional irreducible holomorphic symplectic manifolds are constructed using moduli spaces associated with K3 surfaces or abelian surfaces.

The notion of derived categories of coherent sheaves is compatible with moduli theory, and it is a useful tool to study K3 surfaces and irreducibly holomorphic symplectic manifolds. In the papers [1] and [2], the geometry of irreducible holomorphic symplectic manifolds was studied by using the derived categories of coherent sheaves and moduli theory.

Since the proposal of the homological mirror symmetry conjecture by Kontsevich, derived categories of coherent sheaves have been studied in connection with various fields such as algebraic geometry, symplectic geometry, representation theory, and string theory. It can be said that derived categories of coherent sheaves are invariants which are good at connecting different mathematical objects. In the paper [3], we compared the symmetries of cubic fourfolds and K3 surfaces using the relation between the derived categories of cubic fourfolds and K3 surfaces.

A cubic fourfold is a Fano variety which has similar properties to K3 surfaces in various aspects. In addition to cubic fourfolds, there are several such Fano varieties. We investigate such Fano varieties and K3 surfaces in a unified manner by using the derived categories of coherent sheaves .

Major Publications:

[1] G. Ouchi, Lagrangian embeddings of cubic fourfolds containing a plane, Compositio Math., **153** (2017), no. 5, 947–972.

[2] G. Ouchi, Automorphisms of positive entropy on some hyperKähler manifolds via derived automorphisms of K3 surfaces, Adv. Math., **335** (2018), 1–26.

[3] G. Ouchi, Automorphism groups of cubic fourfolds and K3 categories, Algebraic Geometry., **8** (2) (2021), 171–195.

Education and Appointments:

2017	Ph.D. Mathematical science, The university of Tokyo
2017	JSPS PD, the university of Tokyo
2018–2020	RIKEN iTHEMS Special postdoctoral researchers
2020	Assistant professor, Nagoya University

Message to Prospective Students:

(1) R. Hartshorne, Algebraic Geometry, Graduate Texts in Mathematics **52**, Springer (1977)

(2) M.F. Atiyah, I.G. Macdonald, Introduction to Commutative Algebra, Westview Press (1968)

(3) D. Huybrechts, Fourier-Mukai Transforms in Algebraic Geometry, Oxford Univ. Press, (2006)

(1) is the standard text book for algebraic geometry based on scheme theory. To read the book (1), we need the knowledge of commutative algebra as explained in the book (2). (3) is the standard text book for derived categories of coherent sheaves.