# Preface

The main theme of this book is the Torelli-type theorem for $K3$ surfaces. A $K3$ surface is a connected compact 2-dimensional complex manifold that is simply connected and whose canonical line bundle is trivial. It is difficult to relate the name "$K3$ surface" to its definition, but A. Weil invented the name, with $K3$ resulting from the initials of Kummer, Kähler, Kodaira, as well as from a mountain in Karakoram called K2, which was unclimbed and mysterious at that time. The most famous example is the Kummer surface, discovered in the 19th century. In the case of elliptic curves, that is, 1-dimensional compact complex tori, the period of an elliptic curve determines its isomorphism class. For $K3$ surfaces one can define the notion of periods, and the claim that the isomorphism class of a $K3$ surface is determined by its period is the Torelli-type theorem for $K3$ surfaces. In the 1970s, the Torelli-type theorem was proved and then many results were established using this theorem. Since the 1990s, $K3$ surfaces have become of interest in mathematical physics. Nowadays, $K3$ surfaces are still mysterious: for example, a few years ago physicists discovered Mathieu Moonshine which claims a relation between the elliptic genus of $K3$ surfaces and one of the sporadic finite simple groups called the Mathieu group. The theory of lattices and their reflection groups is necessary to study $K3$ surfaces. In this book we start to explain these notions and give a proof of the Torelli-type theorem and its applications. We hope that this book shows the interplay between several sorts of mathematics. In particular, the author would be happy if this book were to prove helpful to the research of young people.

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