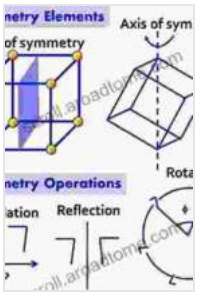
Symmetry of Crystals and Molecules: A Comprehensive and Up-to-Date Treatment



Symmetry of Crystals and Molecules by Mark Ladd

★★★★★ 5 out of 5

Language	: English
File size	: 32473 KB
Screen Reader	: Supported
Print length	: 464 pages
Lending	: Enabled

Symmetry is a fundamental concept in physics and chemistry. It is the study of the invariance of physical laws under certain transformations. In crystals and molecules, symmetry is manifested in the regular arrangement of atoms and molecules. The symmetry of a crystal or molecule can be described by a group of symmetry operations, which are transformations that leave the crystal or molecule unchanged.

The study of symmetry in crystals and molecules has a long history. The first systematic investigation of crystal symmetry was carried out by René Just Haüy in the late 18th century. Haüy's work led to the development of crystallography, the science of the structure and properties of crystals.

In the 19th century, the study of molecular symmetry was pioneered by Louis Pasteur and Jacobus Henricus van't Hoff. Pasteur's work on the optical activity of chiral molecules led to the development of

stereochemistry, the study of the three-dimensional arrangement of atoms in molecules.

In the 20th century, the study of symmetry in crystals and molecules was revolutionized by the development of group theory. Group theory is a mathematical tool that can be used to describe the symmetry of crystals and molecules in a systematic and concise way.

The Symmetry of Crystals

The symmetry of a crystal is determined by the arrangement of its atoms or molecules. The basic unit of a crystal is the unit cell, which is the smallest repeating unit of the crystal. The symmetry of the crystal is the symmetry of the unit cell.

There are 32 possible point groups in three dimensions. The point group of a crystal is the set of symmetry operations that leave the crystal unchanged. The point group of a crystal can be determined by the arrangement of its atoms or molecules in the unit cell.

In addition to point groups, crystals can also have translational symmetry. Translational symmetry is the invariance of a crystal under a translation by a lattice vector. The lattice vectors are the vectors that connect the atoms or molecules in the unit cell to each other.

The symmetry of a crystal can be described by a space group. A space group is a group of symmetry operations that include both point group operations and translational symmetry operations.

The Symmetry of Molecules

The symmetry of a molecule is determined by the arrangement of its atoms. The symmetry of a molecule can be described by a point group. The point group of a molecule is the set of symmetry operations that leave the molecule unchanged.

There are 32 possible point groups in three dimensions. The point group of a molecule can be determined by the arrangement of its atoms in the molecule.

In addition to point groups, molecules can also have molecular symmetry. Molecular symmetry is the invariance of a molecule under a rotation about a molecular axis. The molecular axes are the lines that connect the atoms in the molecule to each other.

The symmetry of a molecule can be described by a molecular symmetry group. A molecular symmetry group is a group of symmetry operations that include both point group operations and molecular symmetry operations.

Applications of Symmetry

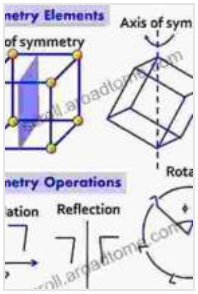
Symmetry has a wide range of applications in physics and chemistry. In physics, symmetry is used to explain a variety of phenomena, such as the conservation of energy and momentum, the laws of thermodynamics, and the behavior of elementary particles.

In chemistry, symmetry is used to understand the structure and properties of molecules. Symmetry can be used to predict the reactivity of molecules, to design new molecules with desired properties, and to understand the behavior of molecules in different environments.

Symmetry is a fundamental concept in physics and chemistry. It is a powerful tool that can be used to understand a wide range of phenomena, from the structure of crystals and molecules to the behavior of elementary particles.

Further Reading

- International Tables for Crystallography, Volume A: Space Group Symmetry
- Molecular Symmetry and Spectroscopy
- Group Theory and Its Applications to Physical Problems
- Symmetry and Spectroscopy: An to Vibrational and Electronic Spectroscopy



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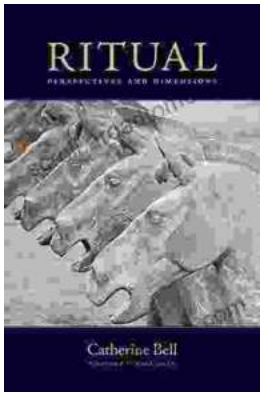

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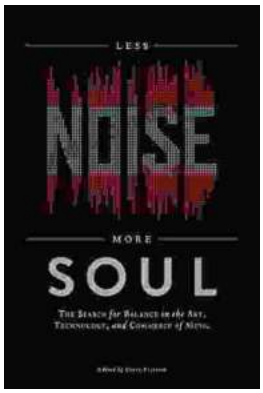

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