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The Main Objectives and Different Methods in Molecular Physics

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Opinion Article

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ABOUT THE STUDY

Molecular physics is a branch of physics that deals with the study of molecules and their properties. It involves the use of physical methods to examine the structure, behaviour, and interactions of molecules, including their chemical and physical properties. The field of molecular physics recognizes that all matter is composed of atoms, which are constantly in motion and mutually attract one another. Scientists in this field study the chemical bonds that exist between atoms, the features of molecules, and molecular dynamics. By understanding the behaviour and properties of molecules, researchers can gain insights into a wide range of phenomena, from the fundamental laws of physics to the behaviour of materials at the atomic and molecular scale.

Objective of molecular physics

The primary goal of molecular physics is to investigate the following: Molecule sizes, shapes, and structure: Molecules are not dull and compact things. They have a structure that must be investigated, documented, and mapped. For example, the interatomic lengths inside the molecule, crystal lattice constants, and angles between nuclei in the molecular configuration may all be measured.

Molecular symmetry: While studying the structure of a molecule, it is the first item to consider. Molecules have amazing spatial symmetry. Binding energies, binding forces, and molecular ionization are all concepts. Molecules' internal energy states. Molecular optical, electrical, and magnetic characteristics. The development of molecular models and the creation of real-molecule theory. Methods for probing and surveying molecules are being developed. Uses and expansion of the subject's relevance to technology, biology, biochemistry, and medicine.

Methods of molecular physics

Molecular structure is studied mainly by three experimental methods are: Molecular spectroscopy, Diffraction methods and Resonance methods. We will discuss these methods in their own chapters ahead. In this section we will outline them as follows:

Spectroscopy: It is possible to accomplish this using both visible and invisible light. As a result, we have optical spectroscopy, infrared spectroscopy, the Raman technique, and microwave spectra. We can calculate molecule energies using spectroscopic techniques. Microwave, far infrared, and high resolution Raman spectra, for example, are useful for determining rotational states. The near infrared spectroscopy provides the linear vibrational energy levels. Optical, ultraviolet, and mass spectrometry are used to determine the electronic energy levels. Spectroscopy in general may also be used to calculate molecular moments of inertia and interatomic separations. Spectroscopy is an effective method for identifying the distribution of atoms within a molecule.

X-ray diffraction: This approach is used to investigate the crystals and molecular structures of solids, particularly those composed of big Z atoms. X-rays have a high penetration rate. As a result, we can calculate interatomic lengths in molecules made up of big Z atoms.

Electron diffraction: This technique is used to analyses gaseous molecules, solid body surfaces, and thin solid layers. It is utilized in situations where X-rays are ineffective.

Nuclear magnetic resonance: It is related to nuclear spin magnetic resonance. It provides information on the molecule's magnetic characteristics. This approach, when combined with spectroscopic methods and the investigation of the Zeeman Effect, offers extensive information on the fine structure of atomic nuclei in molecules.

Electron spin resonance: it pertains to the measurement of the energy changes of the electron spin in a strong magnetic field. This resonance occurs at frequencies $\sim 10^4$ MHz which lie in the microwave region.

Electron nuclear double resonance: it is the combination of Nuclear Magnetic Resonance (NMR) and Electron Spin Resonance (ESR).

Nuclear quadrupole resonance: It pertains to the interaction of the nuclear quadrupole moment with the electric field gradient, i.e., $\underset{Q.}{\leftrightarrow} \underset{\nabla}{\rightarrow} \underset{\varepsilon}{\rightarrow}$ which is equal to a quantized energy of the atomic nucleus. Other method of molecules physics are the following: Molecular beams, etc. Contemporary radio frequency spectroscopy, mass spectroscopy,

macroscopic measurements, classical stereochemistry, laser and Maser in applied molecular physics are all examples of applied molecular physics. Modern approaches for studying the fine structure of molecular nuclei, molecular structure, clouds, and charge distributions, among others, include resonance methods and radio frequency spectroscopy. Another source of information is macroscopic measurements: beams may be measured, and mass spectrometry can be used to investigate individual molecules and controlled collisions. These are both delicate procedures. There are other thermodynamic and acoustical approaches that can provide us with important information about molecules. Contemporary methodologies and sophisticated technology have made significant contributions to the advancement and development of experimental molecular physics.