Electron Spin interactions in Chemistry and Biology

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Holmstrom and Finkel call reactive oxygen species (ROS) as the scientific equivalent of the antihero [1]. However, such unpaired electronic spins are thought to be neither cellular heroes nor villains specifically from a biological perspective that inhabits entertaining and appealing middle ground between the two [2]. The effects of electron spins in the fundamental processes of spin exchange, dipole interactions, intersystem crossing and triplet-triplet (or triplet-singlet) energy transfer(s) have a crucial role in chemical and biological pathways. Electron spin are already used in a variety of applications, such as spintronic and magnetic devices, photocatalysis, and photodynamic therapy, depending on the spin phenomena and instrumentation in the use [3]. The underlying molecular mechanisms involved in chemical and biological processes, however, remain largely unknown [4]. The present book 'Electron Spin Interactions in Chemistry and Biology' aims to rigorously present the fundamental science and utilisation of electron spin interactions, with an emphasis on their reaction mechanisms and structural investigations. This book introduces the key theoretical and experimental background focussing on recent developments to a broad audience of researchers, engineers and undergraduate students in the fields of photochemistry and photobiology, and has the ability to spark interest about its potential. The book is divided into eleven chapters, from foundational theories and processes of electron exchange and transfer to the experimental measurements of electronic spins based on continuous wave and pulse electron paramagnetic resonance (EPR) and, lastly, spin state of organic and inorganic compounds with a special focus on light energy conversion and phosphorescence labels.

One of the most fascinating sections of this book is the described methods to measure free radicals, introducing innovative tools such as Fourier Transform (FT) and transient (TR) electron spin resonance (ESR), electron-electron double resonance (and pulsed electro-electron double resonance), electron-nuclear double resonance, electron-nuclear-nuclear double/triple resonance, two-dimensional ESR and two-dimensional electron-electron double resonance. These form the foundation for spectroscopic approaches enabling the detection of unpaired electrons in the structures of compounds at both atomic and molecular levels. The concept of these techniques is fairly new and could gain credence in upcoming years given that conventionally used EPR and ESR are not sensitive enough to detect nanomoles of unpaired electrons. Interestingly, Professor Likhtenshtein entices us to further pursue the development of advanced one- and two-dimensional conducting and semiconducting materials for optical data storage, sensors for light, heat, and switching units, and luminescent probes for bioimaging by harvesting photons below the energy threshold.

In summary, this book provides key insights into the physics and biology of electron spins and their pivotal role in nature. The final section on the outlook of this mechanism is exceptionally innovative, and therefore this book could both help as a guide and contribute towards future research.

References:

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Scope:

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