Experimental methods employing spin resonance effects (nuclear magnetic resonance and electron spin resonance) are broadly used in molecular science due to their unique potential to reveal mechanisms of molecular motion, structure, and interactions. The developed techniques bring together biologists investigating dynamics of proteins, material science researchers looking for better electrolytes, or nanotechnology scientists inquiring into dynamics of nano-objects. Nevertheless, one can profit from the rich source of information provided by spin resonance methods only when appropriate theoretical models are available. The obtained experimental results reflect intertwined quantum-mechanical and dynamical properties of molecular systems, and to interpret them one has to first understand the quantum-mechanical principles of the underlying processes.

This book concentrates on the theory of spin resonance phenomena and the relaxation theory, which have been discussed from first principles to introduce the reader to the language of quantum mechanics used to describe the behaviour of atomic nuclei and electrons. There is a long way from knowing complex formulae to apply them correctly to describe the studied system. The book shows through examples how symbols can be "replaced" in equations by using properties of real systems in order to formulate descriptions that link the quantities observed in spin resonance experiments with dynamics and structure of molecules.

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Understanding Spin Dynamics
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Preface

Nuclear magnetic resonance (NMR) and electron spin resonance (ESR) experimental techniques are broadly used and highly appreciated in 'molecular science' as they are a powerful tool for studying dynamical processes in condensed matter. Nevertheless (one could say unfortunately) in most cases this knowledge is not easily accessible. The difficulties lie in the fact that spin resonance is a quantum phenomenon and to understand the obtained results one has to firstly understand the quantum-mechanical principles of the underlying processes. Actually this is well described by the term 'spin dynamics'; spin resonances are about dynamics: spin dynamics (i.e., quantum mechanics) and molecular dynamics (i.e., classical motion). This combination is not a disadvantage but a challenge and 'spin dynamics' itself is a part of fascinating science.

Quite often I get the question: Which equation should I use to interpret my data? What should I say? Maybe that there are no closed-form recipes except of a few simple cases and that one should firstly carefully consider the quantum-mechanical properties of the molecular system ...? This answer is correct, but not much helpful. Thus, I do not offer it. Instead of that I decided to write this book. I very much hope that it offers understandable and useful answers to a variety of questions appearing in connection to spin dynamics and spin resonance phenomena. I also believe that it will help to understand the principles, which are illustrated in this book by various examples. In consequence, the readers will be able to develop their own approaches and modify the existing descriptions depending on the system upon consideration, because as per Mark Twain, "Get your facts first, then you can distort them as you please."

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