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Ultrafast Dynamics at the Nanoscale provides a combined experimental and theoretical insight into the molecular-level investigation of light-induced quantum processes in biological systems and nanostructured (bio)assemblies. Topics include DNA photo-stability and repair, photoactive proteins, biological and artificial light-harvesting systems, plasmonic nanostructures, and organic photovoltaic materials, whose common denominator is the key importance of ultrafast quantum effects at the border between the molecular scale and the nanoscale. The functionality and control of these systems have been under intense investigation in recent years in view of developing a detailed understanding of ultrafast nanoscale energy and charge transfer, as well as fostering novel technologies based on sustainable energy resources.

Both experiment and theory have made big strides toward meeting the challenge of these truly complex systems. This book, thus, introduces the reader to cutting-edge developments in ultrafast nonlinear optical spectroscopies and the quantum dynamical simulation of the observed dynamics, including direct simulations of two-dimensional optical experiments. Taken together, these techniques attempt to elucidate whether the quantum coherent nature of ultrafast events enhances the efficiency of the relevant processes and where the quantum–classical boundary sets in, in these high-dimensional biological and material systems. The chapters contain well-illustrated accounts of the authors' research work, including didactic introductory material, and address a multidisciplinary audience from chemistry, physics, biology, and materials sciences. The book is, therefore, a must-have for graduate- and postgraduate-level researchers who wish to learn about molecular nanoscience from a combined spectroscopic and theoretical viewpoint.

Irene Burghardt received her PhD in chemistry in 1992 from the University of Lausanne, Switzerland. She conducted her postdoctoral research at the Center for Nonlinear Phenomena and Complex Systems, Brussels, Belgium, in 1992–1995, followed by research fellowships at the Universities of Bonn and Heidelberg in 1996–1998. From 1999 to 2011, she held a Centre National de la Recherche Scientifique (CNRS) research position at École normale supérieure, Paris, and was appointed CNRS research director in 2007. In 2011, she moved to Goethe University, Frankfurt, Germany, where she holds a full professorship in theoretical chemistry. Her research addresses quantum molecular dynamics and nonequilibrium phenomena, with a focus on materials and biological systems.

Stefan Haacke received his PhD in physics in 1994 from Université Joseph Fourier, Grenoble, France. He was then postdoctoral researcher at the physics department of the Swiss Federal Institute of Technology, Lausanne, Switzerland, with B. Deveaud, and after 1999 assistant professor in the group of M. Chergui. In 2004, he moved to the former Louis Pasteur University, Strasbourg, France, where he is full professor of physics and director of the Strasbourg Institute for Physics and Chemistry of Materials since 2013. His research topics are ultrafast photoinduced processes in photoactive proteins, biomolecules, and organic functional nanostructures, as well as instrumentation for ultrafast spectroscopy.

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