Preface

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EDITORIAL

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Preface

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It is hard to overstate the scientific and technological importance of photochemical processes and reactions. The fundamental changes that molecules undergo following absorption of light drives important processes in wide ranging fields, from biology to catalysis, photodynamic therapies to molecular machinery, covering the entire spectrum of the physical and life sciences. It is a pillar of chemical reaction dynamics, which itself has a long history that includes developments in spectroscopy, crossed-beam techniques, femtochemistry, and extends to present efforts in ultrafast imaging, with many of these topics reflected in past *Faraday Discussions*. The overarching challenge facing photochemistry is that it is predominantly a non-statistical process, strongly influenced by the quantum dynamics of the photoexcited system. Complications include exponential scaling with the number of degrees of freedom, strong coupling of nuclear and electronic motion through nonadiabatic couplings and conical intersections, tunneling, interference effects, and ultrafast time-scales. All of this means that a detailed comprehension remains elusive.

In recent years, new experimental techniques capable of monitoring photochemical processes in unprecedented temporal, spatial, chemical, and energetic detail have appeared. This is in large part due to the development of intense-laser techniques, the construction of free-electron lasers such as the XFEL in Europe and the LCLS in the USA, new sources of pulsed electrons, and advanced detection techniques. The challenges associated with making such measurements are manyfold, and analysis of the signals produced is equally difficult due to the often complex interactions of the pump and probe pulses, meaning that the signals cannot always be directly related back to the dynamics measured. This amplifies the complexity, and means experiment alone is not enough to uncover the true dynamics. Progress in experiments is therefore combined with new approaches and important advances in theoretical modeling of quantum dynamics. The scope and accuracy of the theoretical models is now such that quantitative comparisons between experiment and theory can be made in ever more complex systems and for increasingly complex processes.

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