Physical Chemistry in Action

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Editor

Nucleic Acids in the Gas Phase

Springer

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Preface

Laboratory sciences have bloomed with a variety of techniques to decipher the properties of the molecules of life. Physical chemists and chemical physicists approach the problem by isolating molecules and ruthlessly dissecting them with a variety of tools. One particular way to isolate molecules is to isolate them from their solvent environment. The specific advantages are twofold. First, stripping biomolecules from the solvent makes them amenable to mass spectrometry analysis. Second, isolating the molecules from their solvent enables one to study their *intrinsic* properties. Besides their mass, these properties can be the molecules' structure (from atom connectivity to tridimensional structure), their spectroscopic properties, or their reactivity (for example, with photons, electrons, free radicals, ions, or other molecules) in well-defined energetic conditions. Gas-phase approaches therefore constitute a category of techniques with their own instrumentation, theoretical approaches, and rules for data interpretation.

The objective of this book is to bridge the gap between communities. On the one hand, it aims to give physical chemists a broader view of the potential biological applications of the techniques they develop. On the other hand, the book aims to give chemists, biophysicists, biochemists, molecular biologists, and pharmacologists novel insight into the ways gas-phase techniques can bring unique answers to new types of questions.

Book Outline

This volume is divided into two parts: (I) Methods and (II) Applications.

Part I—Methods—introduces techniques used to investigate the properties of nucleic acids in the absence of solvent and key results: how to transfer nucleic acids from the condensed phase to the gas phase (Chap. 2), the fate of large nucleic acids in the gas phase according to molecular simulations and ion mobility spectrometry experiments (Chap. 3), interaction of nucleic acids in the gas phase with electrons (Chap. 4) or photons (Chap. 5), and gas-phase fragmentation pathways (Chap. 6). Some of these techniques are of course common to the investigation of other

categories of biomolecules (e.g., proteins), but we will highlight here the specificities pertaining to nucleic acid studies.

Part II—Applications—illustrates with four examples the use of gas-phase physicochemical approaches to solve specific questions from fields as diverse as *molecular biology*, with the sequencing of large RNA (Chap. 7), *human health*, with the characterization and quantification of nucleic acid modifications resulting from photodamage (Chap. 8), *pharmacology*, with the screening of drug interactions with nucleic acid targets (Chap. 9), or *structural biology*, with the characterization of RNA folding by mass spectrometry-based approaches (Chap. 10). This list of potential applications is by far not exhaustive, but the key take-home message lies elsewhere. Each of these chapters underlines in its own way the crucial importance of understanding the fundamental physical principles driving nucleic acid structure and reactivity in the gas phase, to conceive tailor-made approaches to solve important problems.

Acknowledgments

I first wish to thank my past team in Liège and my new team in Bordeaux for their support in this research. In particular, I wish to thank Frédéric Rosu, who was part of both and constantly supported me in this adventure of studying nucleic acids in the gas phase. From the Liège University years, I wish to thank Edwin De Pauw, Claude Houssier, and Nicolas Smargiasso, who were particularly eager to bridge the gap between solution and gas-phase biophysical characterization of nucleic acids. I thank Jean-Louis Mergny, director of the U869 ARNA laboratory in Bordeaux, for having welcomed a gas-phase ion chemist in his nucleic acid research lab, and my current team members, Adrien Marchand and Valentina D'Atri, with whom the adventure continues.

This work would also not have been possible without the collaborators and colleagues who made us discover various aspects either on the methodological or on the applications side. I wish to thank Gilles Grégoire, Philippe Dugourd, Modesto Orozco, Mike Bowers, Joel Parks, Tom Rizzo, Manfred Kappes, Dimitra Markovitsi, Alexandre Giuliani, Giorgia Oliviero, Janez Plavec, Naoki Sugimoto, and the CLIO, FELIX, and Soleil teams for having welcomed me to their labs. I also thank the members of COST action MP0802 on G-quadruplex nucleic acids, who helped me to promote mass spectrometry and gas-phase physical chemistry among nucleic acid scientists in Europe. Finally, I wish to dedicate this book to the memory of Jean-Pierre Schermann, a profoundly humanistic scientist whose vision was to bring together the fields of spectroscopy, mass spectrometry, and theory [1]. Without his contribution, I probably would not have met all the people listed above, whose influence shaped my vision touch by touch.

Pessac, France Valérie Gabelica

Reference

1. Schermann J-P (2008) Spectroscopy and modelling of biomolecular building blocks. Elsevier, Amsterdam

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