Experimental insights in gas phase kinetics and conformational dynamics

Frederik Menn[1], Marium Haq[1], Charlène Bouanchaud[1], Luke Mac Aleese[1], Thomas Robert[2], Julien DeWinter[2], Pascal Gerbaux[2], Fabien Chirot[1*]

[1] *Institut Lumière Matière, UM55306 CNRS Université Claude Bernard Lyon 1, Villeurbanne, France*
[2] *Service de Synthèse et de Spectrométrie de Masse, Université de Mons, Mons, Belgique*

Conformational flexibility is key property of molecular species as it modulates their ability to interact with each other and to adapt to their environment. Flexibility is then not only central to the function of numerous biomolecules, but it is also an important characteristic of synthetic molecules. As a dynamic property however, molecular flexibility can be difficult to capture, especially when molecules are in the gas phase. We developed a method, based on mass spectrometry (MS) and ion mobility spectrometry (IMS) dedicated to the characterization of conformational dynamics of complex molecular systems in the gas phase. Namely, our setup uses the ability of IMS to separate conformers in the gas phase as a way to select ionic species with a defined conformation. The selected species can then be subjected to various stimuli, before a second IMS stage used to readout potential conformational changes. Such IMS-IMS scheme has been used in our group to investigate different types of conformational changes, ranging from photoisomerization [1] to spontaneous conformational rearrangements [2]. In this presentation I will focus on the investigation of the kinetics of structural rearrangements using a trap-and release procedure in which the temperature dependance of the kinetics can be determined. This method was applied to synthetic polymers [3], and also to biomolecular species such as peptides, proteins, and peptide complexes. As exemplified in Figure 1, these experiments allow to extract kinetics parameters associated to the investigated conformational changes.

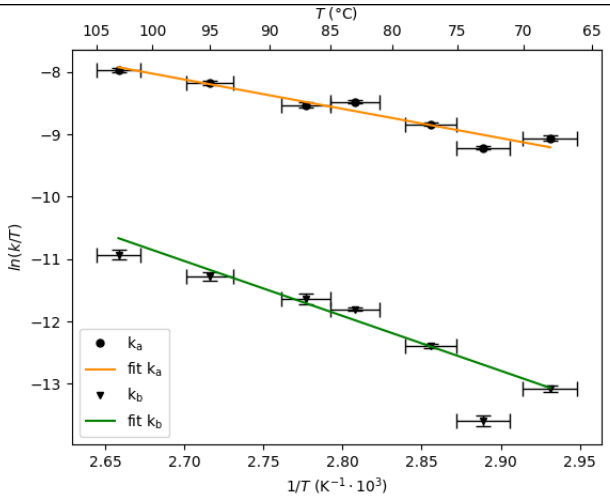

Figure 1 : Eyring's plot representing the evolution of the kinetics constants for the unfolding of two distinct compact states of the Ubiquitin protein. The relative enthalpies and entropies of the associated transition states can be inferred from such plots.

[1] Choi, C. M.; MacAleese, L.; Dugourd, P.; Choi, M. C.; Chirot, F. Photo-Induced Linkage Isomerization in the Gas Phase Probed by Tandem Ion Mobility and Laser Spectroscopy. Physical Chemistry Chemical Physics 2018, 20 (17), 12223–12228. - Czerwinska, I. et al. Supramolecular Influence on Cis-Trans Isomerization Probed by Ion Mobility Spectrometry. Physical Chemistry Chemical Physics 2016, 18 (47), 32331–32336.
[2] Le Fèvre, A.; Dugourd, P.; Chirot, F. Exploring Conformational Landscapes Using Trap and Release Tandem Ion Mobility Spectrometry. Analytical Chemistry 2021, 93 (9), 4183–4190.
[3] Robert, T et al. Back Isomerization Kinetics of Molecular Photoswitches : Complementary Insights from Liquid Chromatography and Ion Mobility Measurements. Analytical Chemistry 2025, 97, 9405–9413.
* correspondant : fabien.chiort@univ-lyon1.fr