

The Second Place Basic Research

Scientific Committee: Chemical Technologies

Research Work Title

Molecular Fold Topology



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Abstract:

Folding of biopolymers, such as proteins and nucleic acids, is crucial for cellular function, with misfolding linked to diseases like neurodegeneration, muscular dystrophy, and cancer. Alireza Mashaghi pioneered the use of single molecule mechanical manipulation for protein fold analysis, advancing our understanding of these processes. Utilizing optical tweezers, the Mashaghi group was the first to observe the folding and unfolding of a protein in the cytosol, the inner environment of a cell. Importantly, Mashaghi invented “Circuit Topology”, a unique fold analysis framework that provides a comprehensive classification of biomolecular structures and chain entanglements, including proteins, cellular genome, and biomolecular condensates. This dual approach offers unprecedented insights into biomolecular folding mechanisms in health and disease, providing a robust platform for future biomedical research and therapeutic developments. Finally, the circuit topology approach inspired new developments in mathematics and is broadly applicable to studying the physics of polymers and engineering new polymeric materials.

Professor Alireza Mashaghi is an internationally recognized physician-scientist who has been affiliated with various academic institutions including Leiden University, Harvard University, Delft University of Technology, ETH Zurich, and Max Planck Institute for Multidisciplinary Sciences. He has served as an advisor for various agencies, including Swiss National Science Foundation, German Research Foundation (DFG), UK Research and Innovation (UKRI), and European Science Foundation (ESF). He also serves on editorial boards of journals including Nano Research.

