Wolfram Stacklies

Force Distribution in Macromolecules

Abstract

All living organisms utilize thousands of molecular building blocks to perform mechanical tasks. These building blocks are mostly proteins, and their mechanical properties define the way they can be utilized by the cell. The spectrum ranges from rope like structures that give hold and stability to our bodies to microscopic engines helping us to perform or sense mechanical work. An increasing number of biological processes are revealed to be driven by force and well-directed distribution of strain is the very base of many of these mechanisms. We need to be able to observe the distribution of strain within bio-molecules if we want to gain detailed insight into the function of these highly complex nano-machines. Only by theoretical understanding and prediction of mechanical processes on the molecular level will we be able to rationally tailor proteins to mimic specific biological functions. This thesis aims at understanding the molecular mechanics of a wide range of biological molecules, such as the muscle protein titin or silk fibers. We introduce Force Distribution Analysis (FDA), a new approach to directly study the forces driving molecular processes, instead of indirectly observing them by means of coordinate changes.