



Efficient Computational Design of Catalysts

Divya Kashyap, Scott Johnson, and Kendall Houk

Louisiana Tech University and Department of Chemistry and Biochemistry, UCLA

Catalysis is a process of accelerating a reaction by lowering the activation energy. Enzymes, biological catalysts, are nature's nanomachines, affecting all the transformations necessary for life. Most industrial processes involve catalysis. Designing catalysts computationally is one of the major challenges to computational chemists. We want to efficiently locate all of the transition state conformations of many different flexible systems in order to computationally design catalysts. We use computer programs that are very efficient at approximating solutions to the Schrodinger equation, the fundamental equation in quantum mechanics that describes the energies and properties of a system. One difficulty in the computational prediction of catalysis is that the reactants can combine in many different conformations and orientations leading to multiple transition states. Our objective is to create an automated protocol for efficient catalyst design and to predict the stereoselectivity of a catalyzed reaction. We will begin by automating the process for a simple system of two ground-state substituted diastereomeric ethanes. A library of all possible substituents will be given as an input. We will develop a program to vary the substituents and determine all conformations and corresponding energies of the diastereomers. The conformational searching will be done using molecular mechanics in Maestro, and the energies will be determined quantum mechanically using Gaussian 03. The resulting program will then be applied to the transition states of the anti-selective Mannich reaction, catalyzed by a modified proline, found previously by our research group. Substituents will be varied in order to design an even better catalyst.