Noncovalent and Reversible Covalent Interactions: Fundamental Studies and Applications in Catalysis

Mark S. Taylor
Department of Chemistry, University of Toronto
80 St. George St., Toronto, ON M5S 3H6
mtaylor@chem.utoronto.ca

Abstract. My group's research is aimed at developing new applications of molecular recognition phenomena. Our program encompasses physical-organic studies of poorly understood noncovalent interactions, the discovery of stimulus-responsive molecules and materials, catalyst design and synthetic methodology. Two projects will be discussed:

(1) Fundamental studies of halogen bonding interactions. "Halogen bonding' (XB) interactions between electron-deficient halogen atoms and Lewis bases have generated much recent interest, with emerging applications in crystal engineering, materials science, medicinal chemistry and biology. Despite developments exploiting halogen bonding in condensed phases, the strengths of the interactions and the feasibility of applying them in the solution phase were not known. Our studies of the thermodynamics of XB in solution and demonstrations of high-affinity molecular recognition based on XB will be described.

(2) Catalytic processes based on reversible covalent interactions of organoboron compounds. Interactions between boron compounds and diols have been studied for decades as the basis for recognition and sensing of sugars. We have discovered new catalytic pathways that exploit these reversible covalent interactions, giving rise to interesting and useful types of chemo- and regioselectivity. The ability of borinic acids to activate specific hydroxy groups in carbohydrate derivatives forms the basis of a broadly useful class of catalytic transformations, including selective protection and regioselective, catalyst-controlled glycosylation. Mechanistic studies and applications of these catalytic processes will be discussed.