Water Availability in Sustaining Hydrogen Ion Migration

Presenters Tate Reece, Mayowa Sonola, and Samuel Wright; Chemistry majors
Mentored by Dr. John Hansen

The solvation of a hydrogen ion (or proton), and its transport through solution, influences perhaps 60% of all chemical reactions and biological processes. The hydrogen ion in bulk water is thought to exist in two forms: the Zundel ion ($H_5O_2^+$) and the Eigen ion ($H_9O_4^+$). These solvated structures aid in the transfer of protons through an aqueous solution via a proton-hopping mechanism. The proton transfer process becomes increasingly interesting as we consider its transfer through the aqueous environment of a cell, which is crowded with many macromolecular structures that interfere with its intermolecular interactions (hydrogen bonding) and subsequent bulk structure.

When studying proton transfer, the complicated aqueous environment of the cell can be mimicked by supercooled solutions of glycerol and water. These solutions, which are homogenous at room temperatures, become increasingly heterogeneous as the temperature is lowered to near the glass transition, with islands of varying viscosity dispersed throughout. Proton transfer in this supercooled solution can be initiated with a very short laser pulse. We studied how these protons migrated through this solution, with limited availability of water to solvate the ions. The experiments discussed here use the rate of proton transfer to probe the mechanism of protons migrating through a heterogeneous medium. We present here how water mobility promotes proton transfer.