Temperature control of the bacterial flagellar motor - a nanoscale rotary electric device.

Biological molecular motors show us how directed motion can be generated by nanometer-scale self assembling devices working at the energy scale of the thermal bath. One of the most ubiquitous engines, the 'salmonella speedboat', is the Bacterial Flagellar Motor (BFM). The BFM is the source of bacterial motility and the world’s fastest bionanomachine capable of rotating at up to 700Hz, and switching direction in response to its surroundings. Uniquely among rotary motors the BFM is powered by the free energy gain of ions transiting the cell membrane, against a membrane voltage and a concentration gradient. A key area of interest in the study of the BFM is how the torque is generated and my research explores the reduction in torque as the BFM responds to being cooled. For this a custom temperature controller was built to work in tandem with the microscope used to measure BFM position with nanometer resolution. As the temperature changes, so too does the membrane voltage and the energy available to drive BFM rotation.

Dr Richard Berry’s group at Oxford focuses on rotary molecular motors namely the BFM and F1F0 ATPase. I will outline the measurement techniques and research carried out in Dr Berry’s group including our recent results regarding Ising-like models of cooperativity in switching, and will illustrate some emerging research areas concerning nanoscale swimmers.