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## **ABSTRACT:**

### Mimicking Nature: Controlling Charge, Heat, and Spin at Interfaces

Many interactions and processes in nature operate at low energy and with critical energy balance, enabling repeated cycling and highly efficient transport. Inspired by these processes, we try to understand them, and to replicate them in synthetic systems. The energies involved are well below those of visible photon energies; thus, we predominantly use tunneling spectroscopies and imaging to probe them. If we could replicate such systems in our devices, we could save most of the energy required to run them. If we could mimic biochemical cycling, we could develop efficient recycling at large scales rather than the extremely labor- and energy-intensive processes of today. We look for underlying principles and what we are currently missing in our understanding. Two of the areas we are exploring are spin conservation in chiral molecules and the roles of polarizability in biological, and now synthetic, systems. Taking this perspective has already led to novel discoveries and inventions, including thermal control with orders of magnitude improvements, in scale, speed, and effect.