Giving Chemistry Direction

Prof David A. Leigh
Department of Chemistry, University of Manchester, UK
(David.Leigh@manchester.ac.uk; @ProfDaveLeigh; http://www.catenane.net)

In recent years examples of synthetic molecular machines and motors\textsuperscript{1} have been developed,\textsuperscript{2} all be they primitive by biological standards. Such molecules are best designed to work through statistical mechanisms. In a manner reminiscent of Maxwell’s Demon,\textsuperscript{3} random thermal motion is rectified through ratchet mechanisms,\textsuperscript{3-8} giving chemistry direction.

It is increasingly being recognised that similar concepts can be applied to other chemical exchange processes.\textsuperscript{9} Ratchet mechanisms—effectively chemical engines\textsuperscript{10} in which catalysis\textsuperscript{4,6,7} of ‘fuel’ to ‘waste’ is used to drive another chemical process—can cause directional impetus in what are otherwise stochastic systems, including reversible chemical reactions. This is ushering in a new era of non-equilibrium chemistry, providing fundamental advances in functional molecule design and the first examples of molecular robotics,\textsuperscript{11,12} overturning existing dogma and offering fresh insights into biology and molecular nanotechnology.

For a musical introduction, see ‘Nanobot’: https://bit.ly/2M5Zwdl