The 963rd IMS colloquium
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Giving Chemistry Direction

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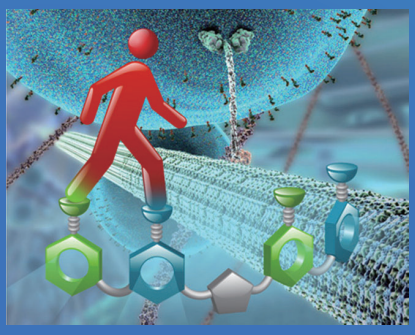
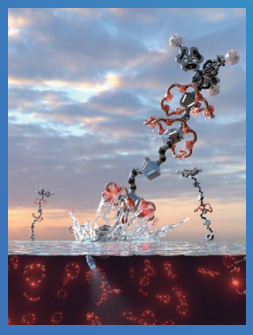
Date & Time: 2023/3/7 (Tue.) 16:00-17:30
Place: IMS Research Building Room 201

In recent years examples of synthetic molecular machines and motors[1] have been developed,[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,[3] random thermal motion is rectified through ratchet mechanisms,[3-8] giving chemistry direction.
It is increasingly being recognised that similar concepts can be applied to other chemical exchange processes.[9] Ratchet mechanisms—effectively chemical engines[10] in which catalysis[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,[11,12] overturning existing dogma and offering fresh insights into biology and molecular nanotechnology.





For a musical introduction, see '*Nanobot*': https://bit.ly/2M5ZwdI

[1] *The Nobel Prize in Chemistry 2016–Advanced Information*. Nobelprize.org. Nobel Media AB 2014. Web. 6 Oct, 2016, http://www.nobelprize.org/nobel_prizes/chemistry/laureates/2016/advanced.html. [2] *"Rise of the molecular machines", Angew. Chem. Int. Ed.* **54**, 10080 (2015). [3] *"A molecular information ratchet", Nature* **445**, 523 (2007). [4] *"An autonomous chemically fuelled small-molecule motor", Nature* **534**, 235 (2016). [5] *"Rotary and linear molecular motors driven by pulses of a chemical fuel", Science* **358**, 340 (2017). [6] *"A catalysis-driven artificial molecular pump", Nature* **594**, 529 (2021). [7] *"Autonomous fuelled directional rotation about a covalent single bond", Nature* **604**, 80 (2022). [8] *"A tape-reading molecular ratchet", Nature* **612**, 78 (2022). [9] *"Design, synthesis and operation of small molecules that walk along tracks", J. Am. Chem. Soc.* **132**, 16134 (2010). [10] *"Chemical engines: Driving systems away from equilibrium through catalyst reaction cycles", Nat. Nanotechnol.* **16**, 1057 (2021). [11] *"Sequence-specific peptide synthesis by an artificial small-molecule machine", Science* **339**, 189 (2013). [12] *"Stereodivergent synthesis with a programmable molecular machine", Nature* **549**, 374 (2017).

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