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Processing signals with (supra)molecular devices and machines

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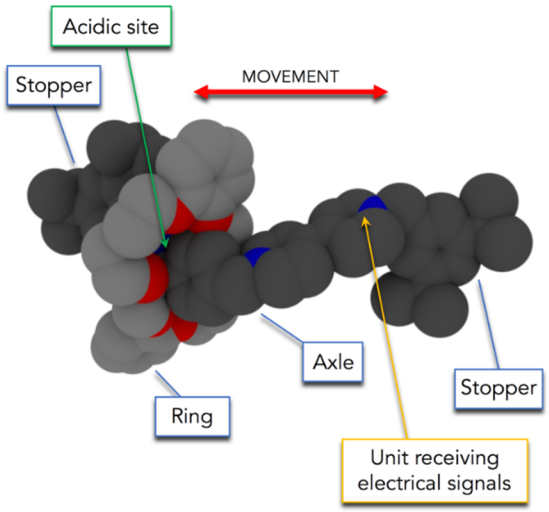
The harvesting, transformation and storage of chemical, electrical or photonic signals by molecular systems constitute key phenomena for the operation of living organisms, and are at the basis of several technological applications. In appropriately designed molecular or supramolecular species, chemical and/or physical stimulation can trigger the occurrence of processes which, ultimately, may result in the ability to carry out useful tasks [1]. The use of light stimulation has several advantages in the present context, primarily because photons can be used to supply energy to the system (i.e., write) as well as to gain information about its state (i.e., read) [2].

Research in the past three decades has shown that molecular-scale devices capable of performing a function in response to external stimulation can be developed by following bottom-up strategies that rely on supramolecular chemistry. Molecular machines are a particular class of molecular devices wherein the function is related to non-trivial, controlled movements of the component parts [1,3]. Indeed, the realization of devices and machines at molecular scale that can harness energy to perform predetermined (and potentially useful) functions in a controllable manner continues to be a most stimulating challenge in nanoscience.

In this talk I will discuss some fundamental concepts of (supra)molecular devices and machines, and present recent results of our research on these topics. Specifically, by inducing and monitoring large-amplitude molecular movements in rotaxane-type systems, we have developed prototypes of molecular pumps [4], transporters [5] and modulators [6] (see figure) that operate in solution. Photoswitchable solid materials for optoelectronic and gas storage applications [7], single molecular tetrapods on surfaces [8] and nanocrystal-chromophore conjugates with engineered long-lived emission [9] will also be discussed.



A rotaxane in whith the pK_a of an acidic site can be modulated by electrochemical switching at a remote site. The possibility of the ring to shuttle between the two sites allows them to communicate.

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