**The nanoscopic version of a macroscopic toy: A light-driven molecular whirligig**

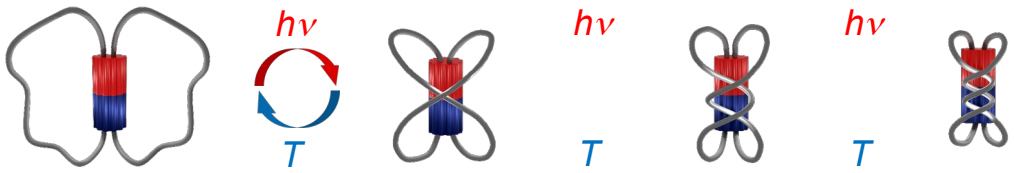
C. Gao, A. Vargas Jentzsch, E. Moulin, N. Giuseppone

Institut Charles Sadron, CNRS, Université de Strasbourg, 67000 Strasbourg, France.

email: vargasjentzsch@unistra.fr

Despite the obvious differences between the macroscopic and nanoscopic worlds, it is often fruitful to find inspiration in our every day's life. This is the approach that many scientists in the field of molecular machines often use. Many examples exist in which macroscopic objects have been the source of inspiration for remarkable pieces of research such as molecular elevators [1] and walkers [2]. There is, however, the fundamental limitation that, at the nanoscale, Brownian motion is a dominant force and inertia is virtually non-existing. Within this context, we decided to attempt the molecular realization of a children's toy: the whirligig craft.

A unidirectional light-driven rotary motor was looped in a figure of eight molecule by linking two polymer chains between its stator and rotor parts [3]. By properly tuning the size of these linkers, clockwise rotation of the motor under UV light was shown to create conformationally strained twists between the polymer chains and, in this tensed conformation, the energy stored in the molecular object was sufficient to trigger the reverse rotation of the motor back to its fully relaxed state [4]. The functioning principle of this motorized molecular device, indeed, resembles the one of macroscopic whirligig crafts.




In addition, we found that in its out-of-equilibrium tensed state, the fluorescence emission of the molecular motor increased by 500% due to the mechanical constraints imposed by the polymer chains on its conjugated core. Finally, by calculating the apparent thermal energies of activation for the backward rotations at different levels of twisting, we quantitatively determined the work generated by this machine, from which a torque and a force can be extracted, thus answering a long-term open question in this field of research.

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[2] M. von Delius, E.M. Geertsema, D.A. Leigh, *Nat. Chem.* **2010**, *2*, 96-101.

[3] Q. Li, G. Fuks, E. Moulin, M. Maaloum, M. Rawiso, I. Kulic, J.T. Foy, N. Giuseppone, *Nat. Nanotechnol.* **2015**, *10*, 161-165.

[4] C. Gao, A. Vargas Jentzsch, E. Moulin, N. Giuseppone, *J. Am. Chem. Soc.* **2022**, *in press*.