



D. A. Leigh

The author featured here has recently published his **25th article** since 2000 in *Angewandte Chemie*:

“Active-Metal Template Synthesis of a Molecular Trefoil Knot”: P. E. Barran, H. L. Cole, S. M. Goldup, D. A. Leigh, P. R. McGonigal, M. D. Symes, J. Wu, M. Zengerle, *Angew. Chem.* **2011**, 123, 12488–12492; *Angew. Chem. Int. Ed.* **2011**, 50, 12280–12284.



The work of D. A. Leigh has been featured on the cover of *Angewandte Chemie*:

“Light-Driven Transport of a Molecular Walker in Either Direction along a Molecular Track”: M. J. Barrell, A. G. Campaña, M. von Delius, E. M. Geertsema, D. A. Leigh, *Angew. Chem.* **2011**, 123, 299–304; *Angew. Chem. Int. Ed.* **2011**, 50, 285–290.

David A. Leigh

Date of birth:	May 31, 1963
Position:	Professor of Organic Chemistry, University of Manchester (my group and I are currently still based in Edinburgh and are moving to Manchester in September 2012)
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Education:	1984 BSc special honours in Chemistry, University of Sheffield 1987 PhD in Chemistry, University of Sheffield, supervisor J. F. Stoddart 1987–1989 Postdoctoral Research Associate at the National Research Council of Canada, Ottawa, supervisor D. R. Bundle
Awards:	2003 RSC Prize for Supramolecular Chemistry; 2004 RSC Prize for Interdisciplinary Research; 2005 RSC Prize for Nanotechnology; 2007 Feynman Prize for Nanotechnology; Izatt–Christensen Award for Macrocyclic Chemistry; EU Descartes Prize for Research; 2009 Fellow of the Royal Society; Merck Award; 2010 Tilden Award
Current research interests:	Design and synthesis of molecular-level architectures including catenanes, rotaxanes, knots, and extremely strong hydrogen-bond arrays through which to control function and properties; synthetic molecular machine systems
Hobbies:	Playing with my 10-year-old daughter, magic (I am a member of my local Magic Circle), and contract bridge (after a 22 year hiatus, I took up the game again in 2008)

If I were not a scientist, I would be ... missing out.

What I look for first in a publication is ... something beautiful (structure, concept, or result).

I like refereeing because ... otherwise Sir Alex Ferguson wouldn't get an extra five minutes added to the end of any game that Manchester United are losing. (Ferguson is notorious for apparently trying to influence referees with regards to time-keeping in key soccer matches.)

The most important thing I learned from my parents is ... don't eat yellow snow.

If I could have dinner with three famous scientists from history, they would be ... hungry.

My favorite place on earth is ... wherever my wife is happy.

My best investment was ... using my salary to buy lab equipment when I got my first independent academic position.

My secret/not-so-secret passion is ... watching Glee with my daughter.

My most exciting discovery to date has been ... applying Brownian ratchet mechanisms to the design of synthetic molecular structures.

The best stage in a scientist's career is ... being a postdoc in a foreign land.

My biggest motivation is ... to feel I've done the best that I can do for my group and my family.

The downside of my job is ... very little. We are so lucky that society values the search for knowledge and understanding sufficiently that people pay their taxes to allow us to work on what we find exciting.

A good work day begins with ... a paper being accepted for publication. A good work evening ends with hitting the “submit manuscript” button.

When I'm frustrated, I ... work even harder.

My favorite author is ... Christopher Brookmyre.

My top three films of all time are ... Schindler's List, My Cousin Vinny, Gigi.

My favorite food is ... pizza from Belle Arti (Bologna) and chinese from the Yang Sing (Manchester).

How has your approach to chemistry research changed since the start of your career?

As our group has grown, and increased in terms of postdoc/PhD student ratio, we've been able to tackle increasingly ambitious projects. We do this by working on problems in small teams of 2–5 people. Progress can be rapid and highly talented researchers can bring their skills to bear on several different projects simultaneously. It's fast-moving, exciting, and I find most people enjoy it more than the traditional one-person-one-project approach.

How do you think your field of research will evolve over the next 10 years?

The field of synthetic molecular machines started with chemists making molecules that had structures reminiscent of pieces of machinery found in the macroscopic world. This was fantastic imagery and generated great excitement for the area, but, as the

dynamic properties of matter at different length scales are so different, it is not actually an appropriate way of designing machines that operate at the molecular level. For a long time, switches were confused with motors, meaning that molecules that couldn't possibly progressively perform work or transport objects as kinesin and other motor proteins do were still called "motor-molecules". This era is starting to change, however, and over the next decade I'm sure we shall see chemists making increasingly complex molecular machines, employing ratchet mechanisms and other mechanistic ideas taken from physics and biology. The result will be genuine synthetic molecular machines that can perform useful tasks at both the molecular and macroscopic levels, including the transport of cargoes along polymers and on surfaces, new types of catalysts and devices, and perhaps even molecular factories.

My 5 top papers:

1. "Facile Synthesis and Solid-State Structure of a Benzylic Amide [2]Catenane": A. G. Johnston, D. A. Leigh, R. J. Pritchard, M. D. Deegan, *Angew. Chem.* **1995**, *107*, 1324–1327; *Angew. Chem. Int. Ed. Engl.* **1995**, *34*, 1209–1212.

The paper that launched my independent academic career. It was a chance discovery that reacting isophthaloyl dichloride and *p*-xylylenediamine formed a [2]catenane. It was clear that a new hydrogen-bonded catenane/rotaxane system could have some potential, but even I was surprised by how far it proved possible to take this chemistry.

2. "Unidirectional Rotation in a Mechanically Interlocked Molecular Rotor": D. A. Leigh, J. K. Y. Wong, F. Dehez, F. Zerbetto, *Nature* **2003**, *424*, 174–179.

We tried to come up with ways of making synthetic molecular motors using catenane architectures and the result was the rotary motor described in the paper. It required a tremendous synthesis involving 20 steps with the last two steps being a 63-membered ring closure by olefin metathesis (proceeding in a remarkable 59% yield) followed by the hydrogen-bond-directed assembly of two additional rings (each formed from four-molecule condensations) about the 63-membered macrocycle to produce the desired [3]catenane.

3. "A molecular information ratchet": V. Serreli, C.-F. Lee, E. R. Kay, D. A. Leigh, *Nature* **2007**, *445*, 523–527.

The [3]catenane rotary motor in Ref. [2] works through

an "energy ratchet" mechanism; that is, the structural changes in the larger ring that result in directional transport of the smaller rings occur independently of the positions of the smaller rings. But a second type of Brownian ratchet mechanism is known in which the position of the Brownian particle (here the transported molecular ring) does influence the changes that result in the particle's directional movement. Such "information ratchet" mechanisms are based on the physics that govern the celebrated "Maxwell's Demon" thought experiment. Here we described how to create such a system using a rotaxane.

4. "A synthetic small molecule that can walk down a track": M. von Delius, E. M. Geertsema, D. A. Leigh, *Nature Chem.* **2010**, *2*, 96–101.

In this paper, the first small-molecule synthetic linear motors are described, namely molecules that walk directionally along tracks without detaching.

5. "A synthetic molecular pentafoil knot": J.-F. Ayme, J. E. Beves, D. A. Leigh, R. T. McBurney, K. Rissanen, D. Schultz, *Nature Chem.* **2012**, *4*, 15–20.

The successful strategy to the molecular pentafoil knot (five crossing points) builds on chemistry introduced by Sauvage (the use of metal helicates to generate crossing points) and Lehn (templating circular helicates with anions). Combining these features with reversible covalent bond formation and stereoelectronic effects to favor ring closure led to the one-pot, 16-component self-assembly of the 160-atom loop pentafoil knot.

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