electric field to the HT phase within this temperature range induced a phase transition to the LT phase (Fig. 1b). They only observed this effect when the electric field exceeded a given threshold value, which shows that the electric-field-induced conversion is a nonlinear process. The electric-field-induced transition involved an abrupt increase of the current flow in these compounds. When the current flow was impeded, no phase change was observed, indicating the importance of the charge-injection process.

Furthermore, the reverse phenomenon — the transition from the LT to the HT phase — could not be induced by the electric field. It could be achieved, however, by heating the system above the phase-transition temperature. Once the HT state was recovered, the phase transition could be induced again with an electric field. The HT-LT transformation could thus be cycled reversibly by alternate application of the electric field and heating. Because the phase transitions involve a change both in magnetization and colour, the compounds can be regarded as displaying electric-field-induced magnetism and chromism switching.

For both compounds, Molnár, Bousseksou and co-workers observed a paraelectric-to-ferroelectric transition during the HT-LT phase transition. On the basis of the existence of the ferroelectric phase with a non-zero dipole moment ρ, they proposed a theoretical model taking into account elastic interactions and electrostatic interactions that stabilize the ferroelectric LT phase by an energy equal to ρE (E is electric field). This model can explain well the observed one-way transition from the HT to the LT phase. As described by the researchers, however, the suggested model cannot explain all of the experimental findings, such as the fact that an electric field of opposite sign could not induce the phase transition.

These findings, as well as other recent examples of electric-field-induced exotic effects, show that focusing on materials with multistability can lead to unusual phenomena by applying subtle external perturbations[1–3]. The two electrically switchable systems described here are promising components for future molecular devices. As the authors suggested, the reverse transition can be induced by a thermal–electrical effect[3], but it might also be possible to induce it by light irradiation. Indeed, this photo-induced phase transition has been reported for several molecular compounds[5,7].

Before the present work, Bousseksou and co-workers had also reported a spin-crossover complex for which both the phase transition and its reverse could be photo-induced at room temperature[7]. Hence, the present findings might lead to the development of new molecular devices with optical and magnetic properties that can be switched by using electric field and thermal–electrical effects, or, potentially, an electric field and light irradiation. ❐

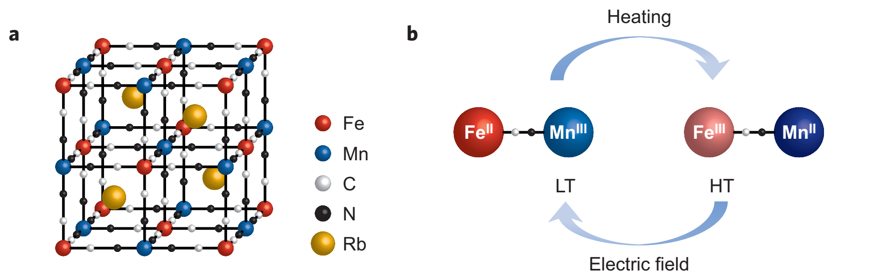

Figure 1 | Crystal structure and schematic representation of the reversible phase transition of electrically switchable cyanometallate complexes. **a**, Crystal structure of $Rb_{0.8}Mn[Fe(CN)_6]_{0.93}\cdot 1.62H_2O$. Reprinted with permission from ref. 3, © 2009 ACS. **b**, Electric-field-induced phase transition from the HT (Fe^{III}-CN-Mn^{II}) to the LT (Fe^{II}-CN-Mn^{III}) phase. After application of electrical bias, the reverse process (from LT to HT) can be induced by heating the compound above its phase-transition temperature. This process can be cycled reversibly.

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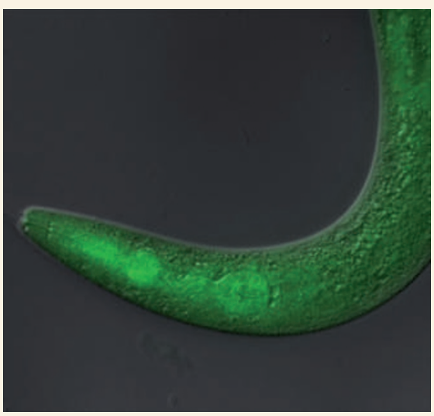
MOLECULAR PHOTOSWITCHES

The worm that turned off



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Molecular photoswitches use light to swap between states that can have different colours or absorption/emission properties. Diarylethylene switches have been used to control chemical and biochemical reactivity, but have not previously been used *in vivo*.

Now, Neil Branda and colleagues have shown (*J. Am. Chem. Soc.* **131,** 15966–15967; 2009) that a molecular photoswitch can reversibly control paralysis in *Caenorhabditis elegans* nematode worms. The transparent worms were incubated in a mixture of the bipyridinium dithienylethene switch and a 10% dimethylsulfoxide buffer. One group of worms was exposed to the ring-open form and another to the ring-closed.

The 'ring-closed' group showed the characteristic blue/green photoswitch colour demonstrating its absorption into the worms (pictured). Although the 'ring-open' group did not, a 2-minute exposure to UV light flipped the photoswitch and the worms changed colour. Worms fed the ring-closed form for 60 minutes appeared immobile, and this paralysis could be turned on and off by alternating their exposure to UV and visible light.

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