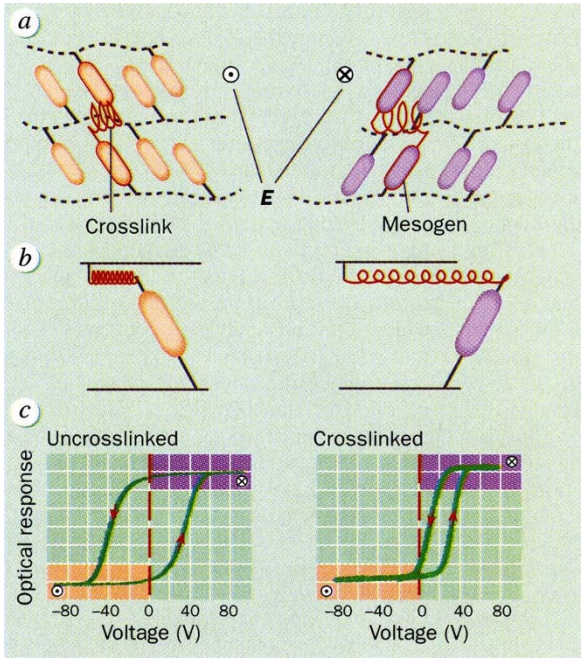

A ferroelectric LC-elastomer and its two switching states. *a*, A polymer chain acts as crosslinking point by connecting different mesogenic groups, attached to the main polymer chains. For an uncrosslinked polymer (without the additional chain acting as crosslinking point), both switching states are equivalent. For a crosslinked LC-elastomer, however, ferroelectric switching extends polymer chains. *b*, The entropy elasticity arising from this acts like a spring, which stabilizes one state and shows up in measurements of hysteresis (*c*). For the uncrosslinked system (left), the hysteresis is symmetric to zero voltage and both states are stable, with no electric field. After crosslinking in one polar state (right), only that state is stable with no electric field, and the hysteresis is no longer symmetric to zero voltage.

crystalline phase are already stretched straight, and can produce new, chevron-like structures which are much stronger under compression than ordinary LC polymers[3] (C. K. Ober, Cornell Univ., and E. L. Thomas, MIT).

Traditional block copolymers are used for their exceptional mechanical properties — rubber-toughened polystyrene, for example, is as hard as pure polystyrene, but much tougher, because cracks can only propagate as far as the next rubber domain and so damage is localized. But many other applications are possible. Phase-separated block copolymers with ionic groups can be prepared with very short ionic blocks. Kinetic freezing (that is, cooling to a glassy state) can then be used to make micelles of different shapes (A. Eisenberg, McGill Univ., Montreal)[4] or to form lateral structures in thin films[5] (M. Möller, Univ. Ulm). Either of these can be used as minireactors, to keep reacting species in place to form nanoparticles of cadmium sulphide or gold, for example.

In liquid crystals, the crosslinking of polymer chains transforms a liquid into a soft rubbery solid, while still allowing enough mobility for liquid-crystal phase transitions. The elasticity of such three-dimensional networks should stabilize the 'smectic A phase', in which there is one-dimensional long-range order perpendicular to the layers, with liquid-like order in the other two dimensions (E. Terentjev, Univ. Cambridge). This LC rubber possesses, therefore, highly directional mechanical properties, combining entropy (rubber-like) and energy (metallic) elasticity in one material (H. Finkelmann, Univ. Freiburg).

In combination with ferroelectric liquid crystals (which can settle into a state that generates a macroscopic electric field), ferroelectric LC-elastomers are possible[6] (see figure). In these systems, different tandem interactions are active. An external electric field can interact with the ferroelectric liquid crystal and lead to switching of the electric polarization (part *a* in the figure). After crosslinking, ferroelectric switching leads to a deformation of the polymer network, equivalent to stretching a spring (*b*). This can be seen by comparing the ferroelectric hysteresis before and after crosslinking (*c*).

One possible application of these materials is in the field of rubbery piezosensors[6] (R. Zentel, Univ. Mainz). As rubber can deform by 100% or more, compared with less than 1% for solid piezoelectric crystals, this is especially promising for electromechanical transducers. They use the inverse piezoelectric effect, in which an applied electric field causes a deformation.

The most provocative contribution, "Can tandem interactions give rise to motion?" (J. Prost, Inst. Curie, Paris), was a theoretical one. It was stimulated by examples from nature like the motor protein assemblies that drive muscles. The hope is to realize motion in artificial systems like microlattices[7], where tandem interactions can stabilize two different spatial structures at similar energies, allowing them to be chemically cycled back and forth in some sort of molecular motor. But just what the details of a system would be is still far from clear.

Often, when an idea is put into words its importance becomes clear, and aspects of a field become evident that had been overlooked or discussed in a 'phase-separated' manner before. The concept of tandem molecular interactions, which are ubiquitous in nature, has the potential to provide new theoretical perspectives in materials science, as well as materials with new properties. □

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The Earth opens up

THIS imposing statuary greets the visitor to the Earth Galleries at the Natural History Museum in London, which opened last Saturday, 20 July. It stands within the visually arresting atrium, its 15-metre slate walls decorated with stars and planets. An escalator whisks the visitor through an 11-metre-diameter rotating globe to two new exhibitions: *The Power Within*, on the Earth's interior, volcanoes and earthquakes; and *Restless Surface*, on the forces that shape the landscape. Four further exhibitions will have opened by the end of 1998. Mounting the exhibitions required the complete refurbishment, at a cost of £12.1 million, of the former Geological Museum, which the Natural History Museum took over from the British Geological Survey in 1985. H.G.