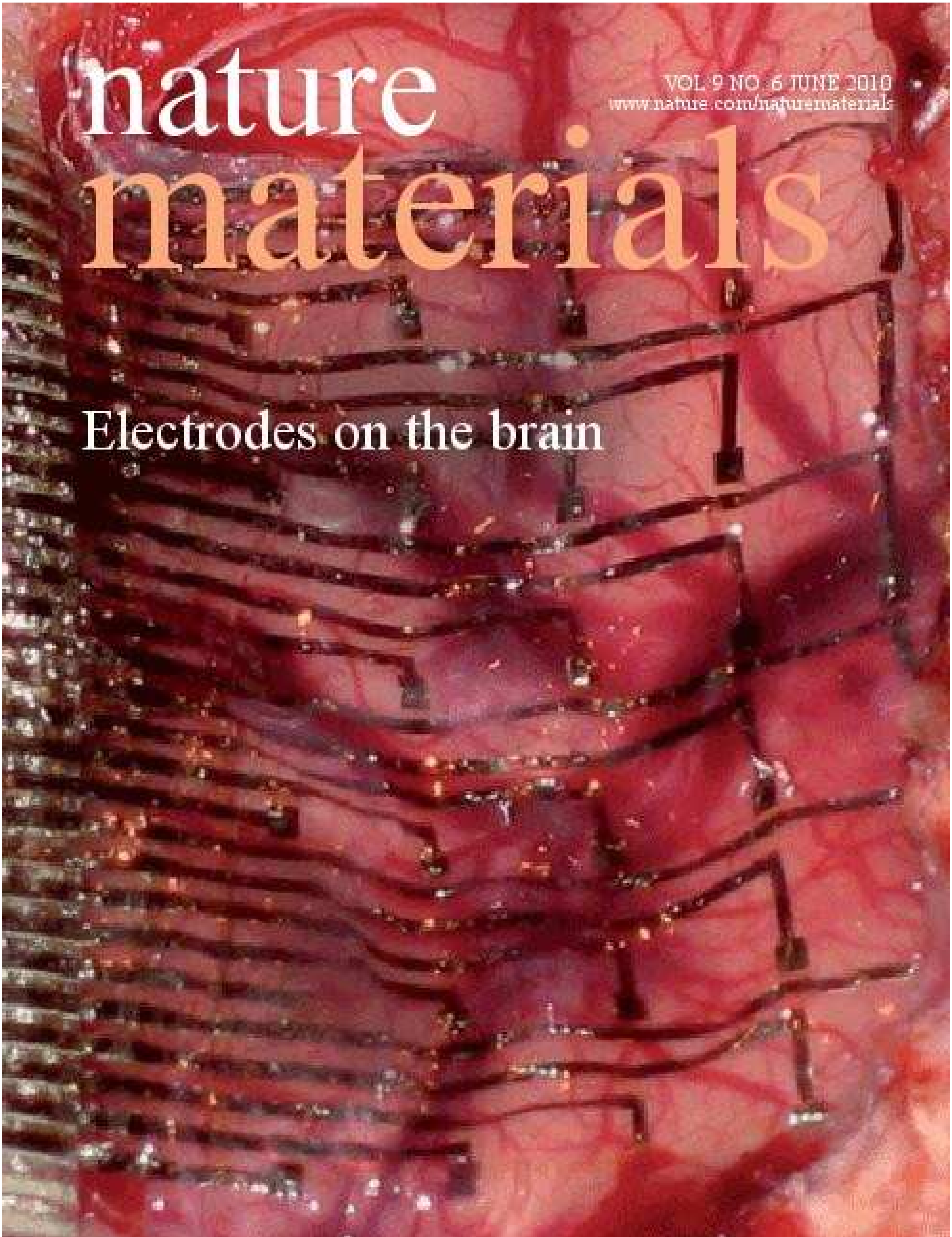

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Electrodes on the brain

MATERIAL WITNESS

MAGNETIC BOTANY

PHILIP BALL

According to Charles Darwin, attempts to explain the mathematical patterns of phyllotaxis — the arrangements of leaves or florets on a plant stem — could "drive the sanest man mad". That hasn't served as a deterrent, because these regular, helical patterns present an irresistible challenge. Their generic form is famously composed of two oppositely rotating clusters of spirals in groups whose sizes are equal to adjacent numbers in the Fibonacci series, inviting geometrical interpretations that pays scant heed to the biochemical details of plant growth. Indeed, the relationship of the leaf arrangements to point lattices on a cylinder was identified in 1837 by the pioneers of crystallographic symmetry, Auguste and Louis Bravais.

What is more, phyllotactic-like spiral patterns have been seen in a variety of non-living systems, ranging from the vortices of superconductors[1] to the self-assembly of inorganic microstructures[2], the buckling of thin sheets[3], and the interaction of magnetic droplets floating on oil[4]. In all of these cases, the structures seem to result from mutual repulsion of the pattern elements, supporting the idea that in plants a new bud is apt to appear an optimal distance from the preceding one so that the arrangement corresponds to a form of optimal packing. Such an ordering can be generated by reaction–diffusion models[5], perhaps instigated in plants by the diffusion of a growth hormone, as Alan Turing suspected over 50 years ago[6].

Last year, Vincent Crespi and co-workers[7] presented a simple experimental system for studying the patterns generated by mutual repulsion of entities in cylindrical geometry. They constructed a 'magnetic cactus', consisting of a stack of disks free to rotate on a central axis, to the edge of each of which are attached magnetic arms with like poles directed outwards. The arms rotate to find a stable compromise position with respect to their neighbours. Crespi and colleagues saw a range of complex dynamical behaviours, such as the propagation of topological soliton-like disturbances along the lattice.

Phyllotactic-like arrangements are certainly achieved in this system, but it was not clear that these are genuine minimal-energy ground states, as earlier models of the spiral ordering have tended to assume[1]. Crespi and colleagues have now found an experimental procedure to magnetically anneal their 'cactus' so that a true ground state can be attained from a disordered initial state[8]. This involves creating small random fluctuations using an external magnet and mechanical vibrations, and continuing the process until the orientation of the arms settles into a stable state. They also simulated this annealing with a genetic algorithm. And the researchers extended their study to the case of two arms on opposite sides of each disk — a situation known in botany as decussate phyllotaxis.

In all cases, the resulting arrangements correspond to the phyllotaxis seen in botanical specimens. Sometimes domains of different structure form along the axis, which share one of the two Fibonacci spiral groupings at the boundary. This establishes Fibonacci phyllotaxis as a generic ground state of repulsive interactions in cylindrical geometry. ❐

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ORGANIC ELECTRONICS

Enlightened organic transistors

Organic light-emitting field-effect transistors surpass the external quantum efficiency of analogous organic light-emitting diodes.

Christian Melzer and Heinz von Seggern

The organic light-emitting field-effect transistor (OLET) is a thin-film transistor based on an organic semiconductor that emits light during transistor operation. The unusual combination of transistor performance and light emission is expected to provide advantages over conventional organic light-emitting diodes (OLEDs), in particular superior external quantum efficiency (EQE)[1]. Yet, for some time convincing experimental proof of higher EQEs has been missing and thus the technological relevance of the OLET has been the subject of heavy debate. Now, a timely and impressive contribution in *Nature Materials* from Raffaella Capelli and co-workers proves the prediction to