

DNA timekeeping



GETTY

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It can be difficult to adjust to a daily cycle, particularly in the morning, but, helpfully, the human body possesses an internal circadian rhythm, powered by a genetic oscillator. A gene is converted into a functional protein, which then inhibits its own transcription from DNA, thus providing a negative feedback. If this cycle is timed correctly, a 24-hour rhythm can be achieved. Although this cycle is understood in principle, there have been many studies on its robustness to stochastic noise.

Luis Morelli and Frank Jülicher introduce a model that shows the influence of stochastic processes on this cycle. Their 'assembly line' model partitions the genetic cycle into a few fabrication steps taking a certain amount of time each. The rate at which this fabrication process is initiated depends on the amount of

functional product (protein) in circulation, thus providing negative feedback. Numeric simulations of the cycle achieve a good description of the circadian rhythm, and show how stochastic processes can actually improve the quality of our internal timekeeping.

Dual magnetism

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The origin of high-temperature ferromagnetism in semiconductors is still a relatively open issue, despite several steps towards a satisfying explanation. It is commonly acknowledged that magnetic impurities are responsible, by inducing order through their magnetic moments. But although experimental data and theoretical models agree on this point, the conclusion clashes with the observation of ferromagnetism in systems obtained by the combination of nominally non-magnetic materials (for example, ZnO and HfO₂ doped with non-magnetic impurities). Miguel Garcia and co-authors have confirmed these observations by studying the magnetic properties of ZnO nanoparticles capped with a variety of non-magnetic organic molecules. By comparing magnetic data with X-ray absorption spectra, the researchers found that in those cases in which ferromagnetism arises, the electronic structure is different from that of non-capped ZnO. The results suggest that room-temperature ferromagnetism in semiconductors has two contributions, one from the magnetic moments of the impurities, and one from the electronic structure modified by the introduction of defects.

Hidden hydrite

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The structure of ferrihydrite has remained elusive, despite its common occurrence in natural sediments and use as an industrial sorbent. Its composition is often given as 5Fe₂O₃·9H₂O, but no formula is widely accepted, and there is disagreement as to its exact crystal structure, with multiple phases often suggested. One problem is that ferrihydrite exists as nanocrystals, which hinder traditional methods of structural determination. F. Marc Michel and colleagues have now used a high-energy X-ray beam to perform total elastic scattering on ferrihydrite, Fourier-transforming the data to produce the atomic pair distribution function (PDF), which produces a real-space model of interatomic distances. They compared this PDF to those calculated from structural models, and determined that ferrihydrite exists as a single phase, with the hexagonal spacegroup *P6₃mc* — a structure that fits the experimental data better than a currently accepted model. Apart from a solution for the long-sought structure of ferrihydrite, this work shows the value of the PDF method for the structural determination of other materials composed of nanoparticles.

Electronic control

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Understanding the interaction of small molecules with transition-metal particles is important for applications such as hydrogen storage and heterogeneous catalysis. The reaction of H₂ and CO with nanoparticle catalysts is relevant to the Fischer–Tropsch process during which these molecules combine to form long-chain hydrocarbons. A crucial factor in this process is the electron density of the supported metal particle, which is directly related to the reactivity of CO towards hydrogenation. André Fielicke and colleagues now report on the co-adsorption of CO and H₂ on small cationic cobalt clusters in the gas phase, and observe how H₂ adsorption modifies C–O bond strength by controlling the electron density available for back donation from the metal to the CO molecule. Each adsorbed H atom reduces the electron density available by an amount depending on the cluster size. This co-adsorption leads to reduced dissociation of CO. Clusters of cobalt with low H coverage at higher temperature are likely to have the highest reactivity with H₂.

Transfer technology



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Energy transfer to phosphorescent molecules is a useful tool in organic light-emitting diodes. Not only does it enable colour tuning, but it also opens up an emissive decay route for usually non-emissive triplet excitations in organic devices, leading to increased efficiency. As two energy-transfer mechanisms are possible between excited phosphorescent

molecules, however — electron transfer (Dexter) or resonant energy transfer (Förster) — precise tailoring using multiple molecules is often a matter of trial and error. Dorothee Wasserberg and colleagues remove some of the guess work in a study that won the *Nature Materials* Symposium E poster prize at the EMRS 2007 Spring Meeting in Strasbourg, France. By exciting a phosphorescent dye in a mixture with two energy acceptors, one capable of accepting energy via both transfer mechanisms, and one only capable of accepting energy via Dexter transfer, the researchers show that in solid films, Förster transfer is the predominant transfer mechanism between their dyes. Such studies should enable finer tuning of emission colours, for instance to achieve much-prized white-light devices.