

Experimental demonstration of violations of the second law of thermodynamics for small systems and short timescales

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Nanomachines pose the problem of violations of the second law of thermodynamics, as entropy could be consumed rather than generated. The fluctuation theorem (FT) formally states the appreciable violations of the second law, an infallible for the Carnot engines, for small systems over short timescales. The authors confirm experimentally, the FT in the trajectory of 6.3 μm latex colloidal particles caught in an optical trap. The set-up consists of an inverted microscope with an oil-immersion objective lens, an infrared laser for trapping micron-sized particles, and a photodiode sensor for detection of particles. Computer simulations of the trajectory are in agreement with the experiments. Results demonstrate that entropy consumption can occur over colloidal length of several micrometres and timescales of a few seconds.

Sexual selection, temperature and the lion's mane

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A lion's mane is sexually dimorphic, and sensitive to ambient temperature, its size being reduced in hot climates. The authors report a study of approximately 300 lions in Serengeti National Park, Tanzania, from 1996 to 2001. Photographs of 568 subadults and adult males from 1964 to 2000 are also analysed. It is found that short manes reflect poor fighting ability or short-term health, whereas dark manes indicate maturity and high levels of testosterone and nutrition. A lion's mane reflects a complex interaction between reproductive benefits and environmental costs.

Comprehensive proteomic analysis of the human spliceosome

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Spliceosome is the macromolecular machine, made of small RNAs and many proteins, that can precisely remove the introns from the pre-mRNA. Several factors associated with the spliceosome are also implicated in genetic diseases like retinitis pigmentosa. Earlier work on spliceosome describes several purified forms of the core particles and small nuclear ribonucleoproteins found in the spliceosome. This work reports the isolation of a complete spliceosome in purified and active form. This new assembly contains about 145 proteins, 58 of them are newly identified components of the spliceosome. The authors used affinity chromatography and characterized the assembly proteins with liquid chromatography followed by tandem mass spectroscopy. While the authors cannot rule out the possibility of discovery of more spliceosomal proteins, they conclude that the purified functional spliceosome contains virtually the complete human spliceosome proteome.

Photoregulation of the transcription reaction of T7 RNA polymerase by tethering an azobenzene to the promoter

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Optical switching of gene transcription is achieved by incorporating an azobenzene moiety near the -10 region of the non-template strand of a T7 RNA polymerase promoter. This new procedure takes advantage of *trans* to *cis* isomerization of the azobenzene moiety induced by optical means that reversibly disrupt normal structures of the DNA duplex, leading to a photo-regulatory switch in the initiation of transcription from a switchable promoter. Transcription can then be turned on by UV irradiation.

Prediction of tensile ductility in porous materials

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The Brown–Embury model for tensile ductility of porous materials predicts a zero value for the fracture strain above a critical pore volume fraction of 0.159. This anomaly arises out of the micro-mechanical considerations in a perfectly plastic material with the assumption that voids are uniformly deformed. The author arrives at a better analytical model applying the Irwin approach to elastic–plastic deformation, that shows the fracture strain depends on the pore size, pore volume fraction and the mechanical properties of the matrix. This new model predicts a zero value for the fracture strain above a critical pore volume fraction of 0.849, that is consistent with the experimental observations that the porous materials have finite fracture strain even at pore volume fractions in the range 0.4–0.6. The predictions based on the new model are highly consistent with the experimental data obtained for the tensile ductilities of AISI 316 and AISI 304 austenitic stainless steels.

Formation of thymine clusters in genomes of higher eukaryotes

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Occurrence of clusters of 10 or more thymine nucleotides is analysed in humans, the flowering plant *Arabidopsis thaliana*, the nematode *Caenorhabditis elegans*, the yeast *Saccharomyces cerevisiae*, and four bacterial genomes, including *Escherichia coli*. The overall frequency of these clusters in human chromosome 22 is approximately 200 times more than what is expected from a random combination. These frequencies are higher in the introns and intergenic regions than in the exons. The cluster frequency appears to increase with increasing genome size, reaching a maximum of 0.7% in humans, with a minimum of zero in *E. coli*.