

In fact, the timescale is sufficient for the creation of massive gravity wells. It may well be that entropy is responsible for organizing the structures, up to and including galaxies and galactic clusters, even before the "phase change" to a "transparent" universe. If this were the case, then there would be no need for any more esoteric mechanism to explain it.

William Lightner  
Rogers, Ark.

*Entropic forces similar to those that organize particles in colloidal suspensions most likely played little, if any, role in the organization of the early universe, physicists contend. The density of primordial particles was far too low to allow the constant jostling among particles that leads to entropy-driven order. Cosmologists also see no parallel between galaxy-galaxy collisions, in which galaxies typically mingle and deform, and the hard body versus hard body, purely repulsive encounters of entropy-ruled systems. At that galactic scale, they say gravity appears to be the dominant force.*

—P. Weiss

**How about entropy** playing a role in the deposition of plaque in blood vessels? Could depletion forces contribute to this phenomenon?

Bob McClintock  
Miami, Fla.

**It occurred to me** that the entropy experiments might provide another computational verification of the problem raised in "Cracking Kepler's sphere-packing problem" (SN: 8/15/98, p. 103). A large number of big balls

and a larger number of small balls would be placed in a container. After allowing time for interaction, the packing of clusters of the big balls far from the container walls would simply be observed.

Several prerequisite questions would need to be answered to prove the approach viable. Does maximizing the restricted regions of overlap of the big balls equate to maximum entropy? Does maximizing those restricted regions equate to tightest packing of the big balls? And what experimental conditions allow the system to reach a global entropy maximum without getting stuck in some local maximum? I suspect that choosing ball sizes that guarantee no overlap of nearby restricted regions can help in answering yes to the first two questions.

Wendell Bishop  
Somerville, Mass.

### Chickadee choices

In "Chickadees sneak up the social ladder" (SN: 7/11/98, p. 27), self-selection and a desire to improve the breed may not be the controlling factors as the wayward female chickadee sneaks up the social ladder. She probably has no alternative. Males ranking below her spouse would be quite unwilling to mate and risk his wrath.

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## Computers

### Chaotic route to computation

Irregular fluctuations in light intensity have long plagued the operation of a wide variety of lasers. During the past decade, researchers have learned how to avoid, control, or exploit such chaotic outbursts by adjusting laser parameters, such as power input (SN: 2/22/92, p. 119). In effect, they can turn a dial to tune a laser's signal so that it flutters randomly, falls into a regular pattern, or remains steady.

Now, researchers have demonstrated in a simulation how a network of chaotic lasers could operate as a computer, adding or multiplying numbers and processing information. William L. Ditto of the Georgia Institute of Technology in Atlanta and Sudeshna Sinha of the Institute of Mathematical Sciences in Madras, India, describe their scheme in the Sept. 7 PHYSICAL REVIEW LETTERS.

The researchers use certain patterns of laser signals to encode different decimal digits, one digit per laser in the network. To perform an operation such as addition, they allow some of the fluctuating light to leak from one laser to another, setting off an avalanche of activity as the linked lasers react to multiple inputs from their neighbors. Ditto and Sinha show that after the system has settled down, the numerical answer is encoded in the network's final behavior pattern.

"There are lots of different ways to do the encoding," Ditto says. For example, "we can change the network connectivity or the chaotic system parameters."

Moreover, the chaotic elements don't have to be lasers. Any network of systems showing chaotic behavior—including electric circuits or nerve cells—will have comparable computational capabilities. "It's an entirely new computing paradigm," Ditto contends. Instead of precisely specifying every tiny step,

a programmer simply sets the initial conditions and lets the system work out an answer in its own way.

Ditto and his coworkers plan to test their idea using chaotic ammonia lasers and, ultimately, a network of nerve cells attached to silicon. "This is a glimpse of how we can make common dynamic systems work for us in a way that's more like how we think the brain does computation," says Ditto. —I.P.

### Factoring reaches new heights

A powerful computer takes just a few seconds to prove that a number consisting of 73 decimal digits is a prime, evenly divisible only by itself and one. In contrast, the same computer typically requires a much longer time to factor a 73-digit composite number into its prime-number components. Indeed, factoring numbers beyond about 130 digits has been impractical. This fortuitous circumstance underlies the widely used RSA method of encrypting digital information (SN: 5/7/94, p. 292).

Now, Herman te Riele and his coworkers at the National Research Institute for Mathematics and Computer Science (CWI) in Amsterdam report that they have factored a 186-digit number—the largest yet cracked—using a technique called the special number field sieve (SN: 5/31/97, p. 340). The number,  $(2^{15} \cdot 135)^{41} - 1$ , turns out to have several factors, including a 73-digit prime and a 71-digit prime. The factorization required 88 computers running for 42 days.

The researchers soon expect to tackle the much tougher task of factoring a number consisting of a string of 512 ones and zeros. If they succeed, they would be able to decode secret messages created using one version of the RSA method. —I.P.